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THE EAST AFRICAN AGRICULTURAL JOURNAL

Issued under the Authority of the East African Governors' Conference and published every three months—July, October, January, April. Volume consists of four issues (commencing July issue).

THE JOURNAL

In the editorial to the November, 1939, number it was recognized that some difficulty might be experienced in maintaining the Journal during the war, owing to shortage and rising cost of paper and to a possible reduction in both contributors and subscribers. Inevitably these factors have been making themselves felt—though the small extent to which subscriptions have fallen is gratifying—and the measures necessary to meet these difficulties have been under consideration. It has been decided in the first place that with the beginning of this new volume the Journal should make its appearance not every second month but quarterly, that is, in July, October, January and April. As a further paper-saving measure the size of the type has been reduced, a decision taken with reluctance because it is realized that the change may bear hardly on those readers who have not the benefit of a modern lighting-system; but the type now adopted is that in which an appreciable, and increasing, proportion of periodical matter is printed elsewhere.

The combined effect of these economy measures will, it is hoped, so far off-set the increased costs of production that it will not be necessary to raise the present very moderate subscription of 5/- a volume. The Journal will certainly look much slimmer, in both the bound volume and the individual number, but the content of the latter will, as planned, be the same as its predecessors.

To meet the often-expressed wishes of both contributors and subscribers an effort will be made to provide, if circumstances permit, a better standard of reproduction for those illustrations the detail of which justify it. Opportunity may, however, be taken to stress that the quality of the final reproduction depends not only on the skill of the block-maker and the grain of the paper surface available but, first and foremost, on the quality of the original photograph submitted. Only for those photographs in which fine detail is important and in which that detail is really well shown would it be justifiable to use an art-paper inset.

It has been suggested that with the completion of the fifth volume of the Journal a cumulative index, constructed in much greater detail than the single-volume indices at present available, would be very useful. The preparation of the quinquennial index has been undertaken at Amani, with a view to its issue to subscribers as soon as circumstances permit.

CORRIGENDA

The following corrections should be made to the May issue of the Journal:—

Page 443, line 8—*For* "XXIII, Vol. 4" *read* "XXIII, No. 4".

Page 445—*For* "on p. 78" *substitute* "under item 78 (page 11)".

FERTILIZER SUPPLY DURING WAR-TIME

By V. A. Beckley, M.C., M.A., Senior Agricultural Chemist, Kenya Department of Agriculture

(*Received for publication on 3rd May, 1940*)

The use of manures and fertilizers in Kenya is still only in its infancy. The coffee industry as a whole uses a fair quantity of both organic manures and the concentrated chemical fertilizers; the cereal farmers generally much less. However, many coffee planters and some cereal farmers have evolved definite manurial programmes. Under normal conditions the dealers in fertilizers carry stocks adequate to meet the ordinary demands and, should an extraordinary demand arise, such as that caused by the recent severe coffee thrips infestation, were able rapidly to replenish stocks by cable orders. To-day, matters are rather different and one has to look around for substitutes.

The main nitrogenous fertilizer used is sulphate of ammonia. A short while ago stocks were very low, but within the last week or two a shipment has arrived.

It can confidently be expected that prices will be appreciably higher; first costs will be greater, while freights and insurance have gone up considerably. It is certain that there will not be a free export of sulphate of ammonia from Great Britain; so much of the combined nitrogen manufactured will be absorbed in munitions. It is probable that part of the agricultural quota will be available for export when the home demand is light. It is also probable that a certain amount may be available from South Africa. One thing that is certain is that the quality will not depreciate as was the case during the last war. One sample seen by the writer then was coloured brown and contained so much tar acids that an application of it to cereals would do more harm than good.

Alleviating the position is the increasing use made of by-products and wastes. From the Nairobi Abattoir comes an appreciably good quantity of blood meal and carcass meal, and from Messrs. Liebig's (Kenya) Limited a greater quantity of slaughterhouse by-products such as blood meal, hoof and horn meal, meat meal, etc. The quantities available are insufficient to meet present demands and, moreover, some of the products are valued as feeding stuffs. The unit values of nitrogen in these products are usually higher than in sulphate of ammonia, but, because of certain inherent characteristics, perhaps worth the extra. Blood meal is nearly as quick-acting as sulphate of ammonia, but leaves no acid residue in the soil; hoof and horn meal is fairly quick-acting and a fair proportion of the nitrogen is slow-acting; a definite advantage with permanent crops.

Other industrial wastes are becoming available as manures. Wastes from fisheries on Lake Nyanza are being produced, but here again the possibility of using fish meal as a feed may reduce its availability as a manure. Another group of wastes from a Lake Victoria industry will help; these are crocodile products, meat meal and scale meal, both of which are valuable manures. There may also be a certain amount of leather waste meal produced. All of these by-products help reduce the demand for imported nitrogen, but they are far from satisfying even a small fraction of the demand.

As regards phosphates the position is easier. The coffee industry uses mainly bone meal, the potential supply of which at present exceeds the demand. Seychelles guano is easily obtainable. As far as can be ascertained, during the past few months there has been a considerable increase in the importation, so stocks should be ample. The superphosphate position will be difficult. A great proportion of our supplies was drawn from foreign sources, which may not or cannot be tapped at present, but it is highly probable that the wheat growers may get almost as good results from the use of bone meal and Seychelles guano.

So far, practically all the potash salts imported into Kenya are of German origin. There are Allied sources, but these will be needed to meet demands elsewhere. On the whole, there is very little need in Kenya for special potassic manuring, so agriculture will not suffer from lack of potash. In the few cases where it is needed the deficiency can be met by the use of wood ash or maize cob ash.

There is a tendency on the part of some coffee growers to use compound manures, some of which are based on fish meal. It is to be feared that the supply of these will cease during the war period, and habitual users will have to look for substitutes. The most promising source lies in the slaughterhouse by-products.

It will become more and more necessary for planters and farmers to look to the waste products of their own farms for the maintenance of soil fertility. Although many farmers are using agricultural wastes in the form of composts, there are others who do not because they are afraid of heavy expense. Composting need not be expensive, though it can be made so, and the returns more than compensate for the cost. A Kenya farmer made between 1,300 and 1,500 tons of compost in 1937-38, which was placed on 130 acres at a total cost of Sh. 5/50 per acre. He reckons that during the first year alone, after manuring, his profit was Sh. 21 per acre [1]. Others have done as well.

The principles of composting should now be well known. Sir Albert Howard's book, *The Waste Products of Agriculture,* is in many farm libraries. The principles, as applicable generally to Kenya conditions, have been described [2] [3], and the application of the principles to particular conditions have formed the subject of several articles in this Journal [4] [5] [6] [7], so it should not be necessary to traverse the subject again.

The whole secret of success in making compost cheaply is the adaptation of the basal principles to the conditions and materials. Slavishly following a detailed schedule of mixing, watering and turning, worked out for one set of conditions, is certainly going to increase the cost. While it may be economic on a small peasant holding to collect weeds from the fields for composting, it is foolish to do so on a large coffee plantation; the weeds will decompose in situ without detriment, and seeds will be left to continue the succession.

Cost does not involve only the actual labour, but capital outlay may constitute the greater part. To produce a superlative compost will involve a lot of labour mixing up the wastes, transporting them to and from the cow-byres, watering and turning at the stated intervals, but also the provision of a proper water supply at the composting site. Such a compost may well cost Sh. 15 per ton. On the other hand, "rain-water compost," where labour requirements are reduced to a minimum and there is little if any capital expenditure, will give a less perfect product but the cost will be about one-tenth of the other. Equal applications of the two will not differ greatly in their effect; the increase in the one case may cover the costs, in the other it will yield a handsome profit. Better an ample supply of a poor compost than a meagre supply of a superlative.

With the increasing swing-over to mixed farming, the production of larger and larger supplies of compost will become easier. The crop wastes available at present are, in many cases, a liability. Proper use of them as bedding will enable the farmer to convert all the wastes into usable, valuable compost, and at the same time benefit his stock. It is not necessary to haul everything to a central point; often this would be uneconomical. Judicious planning is needed. One well-known farmer [7] combines his soil-conservation systems, stock *bomas* and composting into economic units.

The matter is not so simple on coffee plantations. Many are able to plant heavy-yielding crops on part of their estates to provide the bulk material for composting, but many more have no spare land for the purpose. The only waste product is the pulp, not an easy material to compost alone, and in any case insufficient to meet the needs. A lot can be done by proper use of the weed growth. At the onset of the rains more plant nutrients are rendered available than can be utilized by the crop, and a great proportion of the nitrates may be leached down beyond the reach of the roots. A good growth of weeds is capable of utilizing much of this surplus, and putting it into storage, as it were; one common weed, pigweed (*Amaranthus* sp.), takes up far more nitrates than it can use. If now the weeds are lopped or turned in while still young, before most of the nutrients taken up are stored in seeds and before they become woody, decomposition will proceed without detriment to the main crop. If left too late, much of the nutrients will be locked up and, during the preliminary decomposition of the woody residues, there may be a heavy demand on the available plant nutrients in the soil, to the detriment of the crop. The underlying concept in the composting of crop residues is the reduction of the woody residues, so that on application to the soil further decomposition will not involve depletion of the available nutrients. Careful utilization in this manner of heavy weed growth should enable those planters, who are lucky enough to have their soil in such trim as to carry a heavy weed growth, to pass through the war years without needing to purchase large quantities of imported fertilizers and thus to leave more for their more unfortunate neighbours.

It is possible to convert all town wastes into valuable manures. This has been done in India

for years, and is now being done by municipalities and boroughs in Great Britain. Even in Nairobi we have a compost factory that is quoted as an object lesson. The question is how far would it be possible for such composts to be used. They are bulky, and will stand but little cost of transport before becoming uneconomic. However, the potentialities must not be overlooked. The careful utilization of locally available products, the composting of farm wastes, and, when economic, the conversion of town refuse into manure will go a long way towards meeting the demand of the Colony for manures and fertilizers.

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THE POSSIBILITIES OF VEGETATIVE PROPAGATION OF COFFEE IN TANGANYIKA

By R. B. Allnutt, B.Sc. (Agric.), Agricultural Officer, Tanganyika

(*Received for publication* 29*th April*, 1940)

In a previous number of this Journal [1] there appeared a reprint of an article on the possibilities of the vegetative propagation of coffee, written by Mr. W. Mayne, Senior Coffee Officer at the Mysore Experiment Station at Balehonnur, with special reference to conditions in the coffee district of Southern India. The purpose of this note is to examine the applicability of some of the statements made and views expressed in that article to conditions in East Africa. I am indebted to Mr. L. M. Fernie, Agricultural Assistant, Lyamungu, for helpful criticisms of the original draft. The responsibility for the views expressed is, however, solely mine.

Mayne states that "although so far propagation by cuttings has not passed the experimental stage it seems that it only awaits the discovery of the right conditions for high percentages of success." Is this true of East Africa? Fernie, working at the Coffee Research Station, Lyamungu, Tanganyika, in an experiment with four different rooting media, obtained an average of 65.79 per cent successfully rooted cuttings; the average time taken by a cutting to root was 17.38 ± 0.21 weeks. [2] With the best medium of the four, 79.47 per cent of cuttings rooted, the average time being 16.2 ± 0.39 weeks. The same worker, with quite a modest set of propagating frames, has been producing up to one thousand rooted cuttings per month, using an almost standardized routine, which he has recently described in this Journal. [3] In view of these results it seems reasonably certain that propagation by means of cuttings on a commercial scale is already possible, at any rate at Lyamungu.

The behaviour of trees raised in this way has not yet been determined, but if it comes up to expectations—that is, if the clonal progeny of mother trees which give high yields of good quality coffee repeat their parent's performance—there will be a big demand for this type of material. It is possible that the capital outlay and the close supervision required to ensure a high percentage of success in rooting cuttings may be beyond the means of small estates, and it will almost certainly be beyond the means of native growers. But what of it? How many fruit-growers in Europe raise their own planting material? We already have professional nurserymen in East Africa. Can they not extend their activities to coffee? Possibly in the early stages the local agricultural departments would have to fulfil this function, but the point is that the trees can be raised with certainty and with reasonable speed, when the time is ripe.

It is possible that results as good as those obtained at Lyamungu might not be achieved in all coffee parts of Tanganyika, particularly in the drier areas. No serious attempt has been made elsewhere in Tanganyika to raise rooted coffee cuttings in quantity, and we must not be

over-sanguine until Lyamungu methods have been tried elsewhere. Nevertheless, even if it is found that special climatic conditions are necessary for success, it will surely be possible to supply most coffee areas from selected centres. Cuttings rooted at Lyamungu have been successfully established in the Arusha area, in the Usambaras, and even as far afield as the Southern Highlands. In the latter case an experimental consignment of rooted plants was sent by air. Air transport will probably be too expensive for commercial consignments, so that until it is shown that cuttings can be successfully raised in the Southern Highlands, it is perhaps premature to be confident that that area can be supplied with vegetatively raised plants in commercial quantities. The same remarks apply *mutatis mutandis* to the Arabica areas of Bukoba. But this still leaves the far more important coffee areas of Kilimanjaro and Meru, where there should be no difficulty.

A second point arises from Mayne's statement that "the necessity for taking scions from vertical shoots if a normal type of tree is to be obtained means that the number of scions that can be taken from any one plant in a season is very restricted", and that "with the very large number of trees per acre in Southern India the provision of scions for the grafting of any substantial area would present very serious difficulties." The difficulties apply equally, of course, to the replacement of old coffee by rooted cuttings or to the establishment of new areas with either cuttings or grafted seedlings.

How serious are these difficulties in Tanganyika? At Lyamungu it is not at all exceptional for a plant to yield between one hundred and one hundred and fifty cuttings in a year, if it is pruned and trained for this specific purpose. If we assume an average yield of only 50 cuttings per tree, and only 50 per cent success in rooting, it means that one mother tree would supply twenty-five successful rooted cuttings per year. In other words, at identical spacings, one acre of mother trees would supply plants for 25 acres of coffee per year. As a corollary, 332 acres of mother trees would supply enough plants in ten years to replace the whole of the existing 83,000 acres [4] of Arabica coffee in Tanganyika. It may be objected that it will take a long time to establish those 332 acres of mother trees, but in practice this should not be so, for the following reasons: Normally, no tree will be worthy of extensive use as a source of scion material unless it has been subjected to several years of observation as to its yield, quality, vigour, etc. Some years before the conclusion of this period of observation it will have become evident that the plant shows great promise; and at that stage it will be propagated vegetatively in order to obtain an early supply of clonal material. By the time the testing period is finished, this material will have reached an advanced stage and will be immediately available for intensive multiplication.

If grafting or budding of established trees proves to be more advantageous than the replacement of old areas by rooted cuttings, progress would at first be slower, because hardwood cuttings are needed for budding and grafting, and the number of hardwood cuttings obtained from a tree over a given period is very much smaller than the number of softwood cuttings, which are used for raising rooted plants. But once grafting had been started, each grafted tree would in turn become a source of cuttings for top-working more trees, so that the supply of scion material would increase in geometric progression year by year.

There seems therefore to be good justification for concluding that the improvement of coffee by means of vegetative propagation is within closer range of practical realization in Tanganyika than one might suppose if Mayne's most interesting and informative article were read without considering recent local developments, the details of which had not been published at the time his article was written.

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PISE DE TERRE: A CHEAP METHOD OF ENCLOSING LAND OR FIELDS

By W. S. Read, P.V.S., Superintendent, Government Cattle Farm, Hissar

Reprinted in shortened form from Agriculture and Live-stock in India, *July,* 1939

For many years the management of the Government Cattle Farm, Hissar, has been in search of some method of building labourers' quarters, godowns, cowsheds, enclosure walls, etc., cheaper than masonry and cheaper and more lasting than sun-dried brick. The solution has now been found in *pisé de terre* (rammed earth).

Sixty-five labourers' quarters of *pisé de terre* are now in course of construction on the farm. This article should only be regarded as a preliminary note. The information given herein, however, is sufficient to enable cheap and lasting boundary walls to be constructed by unskilled labour.

Pisé de terre (rammed earth) must on no account be confused with the sun-dried brick, and mud-walling operations, carried on in many parts of this country. Advocates of *pisé de terre* have the greatest difficulty in convincing the uninitiated that this type of construction is different from and much stronger and more permanent than sun-dried brick or mud walls. Mud (wet, soft earth) has no place in *pisé de terre* practice.

Building construction in *pisé de terre* is no new or modern invention. It has stood the test of time. Pliny mentions it in his *Natural History*. The Romans introduced it into France and building of *pisé de terre* have been erected in England, Africa, Australia, New Zealand, Mexico, and California, representing a very wide range of climatic variation. Even in India *pisé de terre* is not unknown, as work of this description was carried out at Etah Gaol in 1867-68.[1] Nevertheless, although building in *pisé de terre* has been practised for so many centuries in so many widely spread countries, the process is still unknown to the mass of the general public. Moreover, those who have had experience of this cheap and simple method of construction are most enthusiastic regarding its merits. One is therefore forced to the conclusion that the only reason for it not being more widely known and practised is prejudice on the part of the building trade, because it throws open a field for unskilled labour, supervised by very few skilled or semi-skilled artisans. On the work now in progress at Hissar the only tradesmen employed are two masons on about one shilling each per diem and one carpenter on about eighty cents per diem. [Given in the original as 10 annas and 8 annas respectively.—*Ed.*] The remainder of the gang are all entirely unskilled labourers.

The whole process of *pisé de terre* building construction can be condensed into a few words. It consists of erecting parallel wooden shutters on the site of the wall to be erected. The distance between these parallel shutters being the width of the wall required. A layer of fine earth (not mud), some four to five inches deep, is spread evenly between the shutters. This earth is well rammed with wooden rammers until they fail to leave an impression upon it. Similar layers of earth are spread and rammed until the top of the shuttering is reached. The shutters are immediately dismantled and set up for the next section. The full height of the wall is reached by placing the shutters on the courses of the wall already completed. Several sets of shutters may be in use at the same time, for as soon as two sections of the first course are finished the second course can be commenced. When two sections of the second course are ready, the third course can be commenced, and so on. The work thus progresses in a series of steps, which eliminates the necessity for ladders or scaffolding.

Details for constructing a pise de terre wall 15 inches thick and 6 feet high, inclusive of 6 inches as foundation

I—Materials required

(*a*) *Shuttering.*—There are several types of shuttering in vogue, designed to suit individual fancy and the standard of the labour to be employed. There is a big field for research in shutter design for *pisé de terre* work.

For the work at Hissar, shutters of the utmost simplicity and cheapness were evolved, devoid of all complications, such as special moulds for corners or for joining walls at right angles. External braces and scaffolding were also eliminated. In this case, the length of the pairs of shutters was determined by the fact that blocks of quarters with rooms 10 ft. by 10 ft. were to be built. Shutters 7 ft. 3 in. in length were made to allow of each course of each 10 ft. wall being built in two sections, with allowances for overlap at the joint and for

[1] The author has since received information that the gaol wall at Etah is still standing and that all the maintenance it ever requires is an occasional plastering.

interlocking with adjoining walls. For an ordinary straightforward boundary wall, shutters 9 ft. in length can be used. Longer than this might be found heavy and unwieldy in operation.

To commence operations, construct an even number of shutters from any hard, dry, well-seasoned wood, each 9 ft. by 2 ft. by $1\frac{1}{4}$ in., strengthened with four battens each 2 ft. by 6 in. by 1 in., riveted on to one side of the shutter only (Diagram 1). The inner face of the plank to be as smooth as possible, with the heads of all batten rivets filed down flush with the wood. Holes $\frac{3}{4}$ in. in diameter should be bored through the battens and plank, centred exactly 3 in. from the edge of the plank, to take the metal distance rods. Each hole should be protected by metal plates on both the inner and outer faces of the shutter. The inner plate prevents damage to the shutter by the shoulder of the distance rod, and the outer plate protects the batten from damage by the distance rod wing-nut. An iron handle is fixed to each batten to facilitate handling. A strip of 1 in. angle iron is nailed to the inner edges of the shutters to save them from damage by blows from the rammers.

(*b*) *End-planks.*—Several plain "end-planks" (for square corners) will be required, for leaving spaces for gateways through the walls. One or more "end-planks" (for making a rounded corner) will also be required. Rounded corners

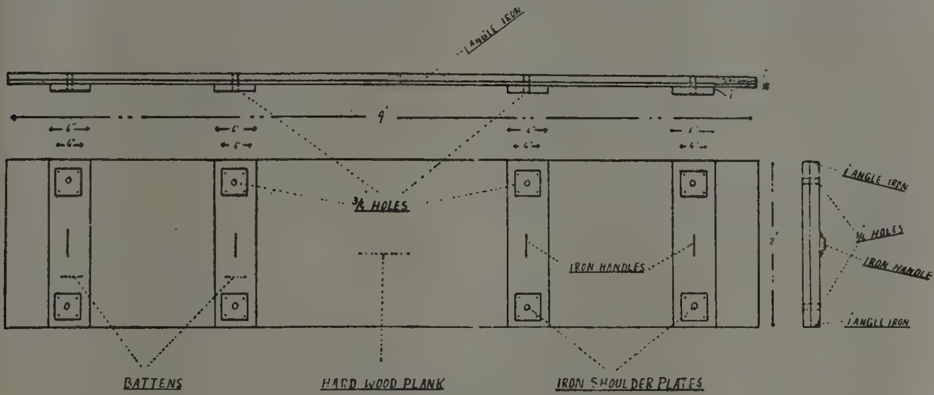

Diagram 1—Side planks

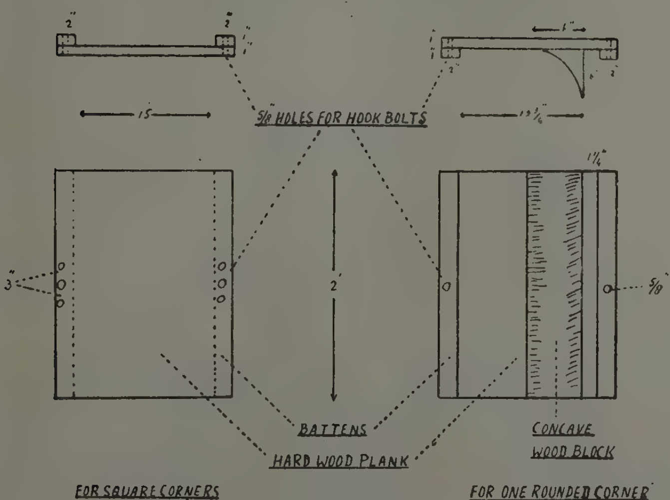

Diagram 2—End-planks

are usually made on the outer angles of walls to prevent chipping and damage.

The dimensions of these end-planks are given in Diagram 2.

(*c*) *Hook-bolts.*—Each end-plank will require two hook-bolts, the dimensions of which are given in Diagram 3. The method of fixing is to place the end-plank in position at the end of a pair of shutters, where a finish-off for a gate or doorway is required. Pass the hook-bolts through the holes in the end-plank, and run the nuts on a few turns. Engage the hooks over the edges of the two end battens of the shutters, and tighten up the wing-nuts until the end-plank is securely fixed in position.

(*d*) *Distance rods.*—It is quite obvious that to build a good straight wall the pairs of shutters must be kept exactly parallel. This is achieved by means of "distance rods". Most writers remark on the difficulty of removing these rods from the wall after the earth ramming is completed. Some workers, in fact, prefer elaborate bracing mechanism outside the shutters instead of distance rods, because of the difficulty experienced in extracting them and the damage often done to the wall in the process.

To overcome this difficulty the author evolved the "taper distance rod" illustrated in Diagram 4, which is completely successful. A light tap with a piece of wood on the taper end of the rod loosens it sufficiently to enable it to be withdrawn from the wall without any damage. The "taper" distance rod illustrated has an inner dimension of 15 in., but any size can be made, according to the thickness of the wall required. Any blacksmith can prepare these rods and the iron fittings for the planks. The planks can be built by any village carpenter.

Eight distance rods should be provided for each pair of shutters, although in actual practice only four are used. The surplus allows of the upper rods being left in the wall when the shutters are removed, so that they can be used as bottom rods when shutters are placed for the next course of the wall. The extra rods also provide a reserve against breakage or damage.

(*e*) *Rammers.*—The dimensions of the rammers used are shown in Diagram 5. They should be made of hard, well-seasoned wood, free from knots and cracks. The striking surface should be finished off completely smooth. Each rammer should be fitted with a long bamboo handle. The half-round rammer (B) is used for ramming the earth in corners and along the sides of the shutters, and also adjacent to the distance rods. Two square rammers (A) and one half-round rammer (B) should be provided for each pair of shutters. Two *beldars* (labourers) to each mould are required for ramming.

(*f*) *Soil.*—Almost any good arable soil is suitable for *pisé* work. Heavy clays and light sands should be avoided. Soils can, of course, be blended: heavy soils with an admixture of sand and light soils with an admixture of clay. The soil used must be dry, not wet, and the simplest test to prove the soil prepared is to grip a handful tightly for a few seconds. If on opening the hand it remains compressed in a ball, the moisture content is too high. If it breaks down into dusty particles too rapidly,

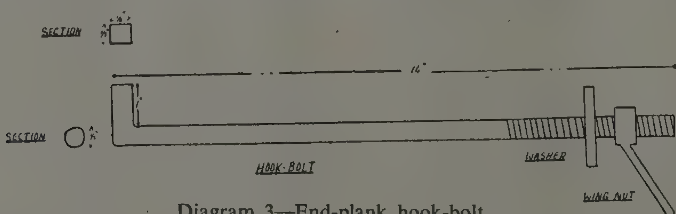

Diagram 3—End-plank hook-bolt

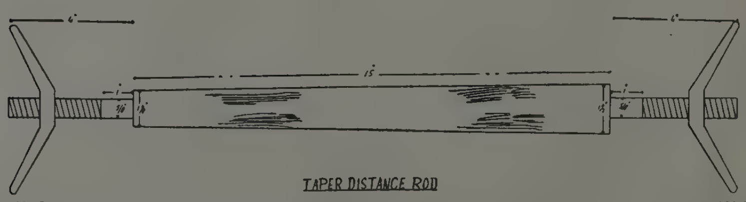

Diagram 4

it is too dry. If it cracks and disintegrates slowly, it is correct. This test should be applied frequently and regularly throughout the operations.

The soil should be broken down finely, and none of the particles should exceed the size of a walnut. No grass or other vegetable matter should be permitted to remain in the soil, nor should more soil than the quantity required for the current day's work be prepared at one time. The surface of the area from which the earth is taken should first be removed and placed on one side, to avoid having vegetable matter in the soil to be used. If the soil is excavated to a considerable depth, care should be taken to see that there is no change in the soil formation. If any change is found, the material should be blended to the correct consistency.

II—Building operations

(*a*) *Foundations.*—If desired, the foundations for a heavy building may be of burnt brick, the top course of which should be of the same width as the wall to be erected, so that the shuttering may be firmly clamped on to the same. For an ordinary enclosure wall, however, a brick foundation is not necessary and in any case adds to the cost.

Dig a trench on the site of the wall to be erected, 2 ft. 15 in. wide and 6 in. deep. In the centre of the bed of the trench mark off two lines 15 in. apart, running the full length of the trench. Dig out a further 6 in. of earth on each side of these lines, leaving a foundation ridge 6 in. high and 15 in. wide (Fig. 1). From the ends of the trench run out similar trenches at right angles until the whole area to be enclosed is surrounded. Gaps should be left in the trench where gateways in the walls are required. Level off the top of the foundation ridge where necessary.

Commencing at one corner of the enclosure, join two shutters together with the four distance pieces, leaving the wing-nuts loose. The distance rods should not be one above the other. Also see that the thick ends of the bottom taper rods are not both in the same side, otherwise the shutters (which now become a mould) will not stand vertically on the foundation ridge. The mould should overlap the second foundation ridge which runs off at right angles. A narrow groove must be cut in this ridge to accommodate the first fifteen inches of the inner shutter, otherwise the mould will not stand upright. Next tighten up the wing-nuts until the mould has taken a firm grip on the foundation ridge. Use a spirit-level and plumb-line to set the mould perfectly upright. At the wall-angle end of the mould, fix the end-plank in position, using one which will provide for a rounded corner on the external angle of the wall. No end-plank is required at the other end of the mould.

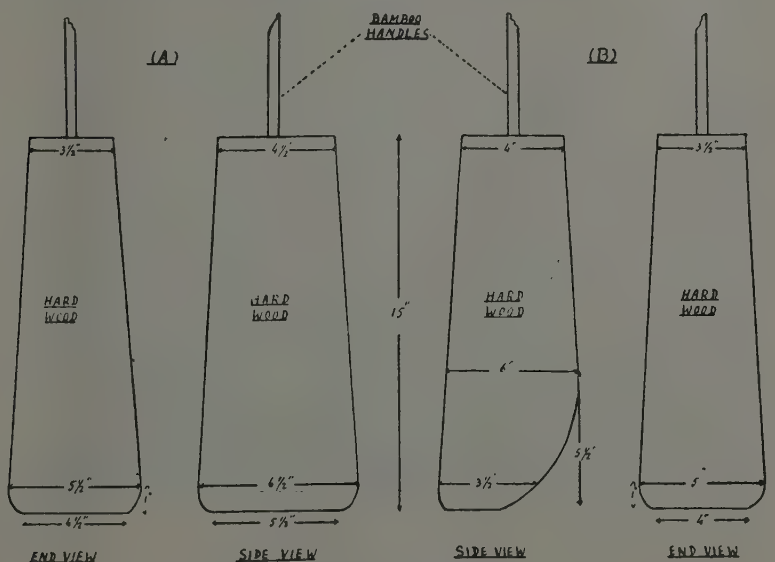

Diagram 5—Rammers

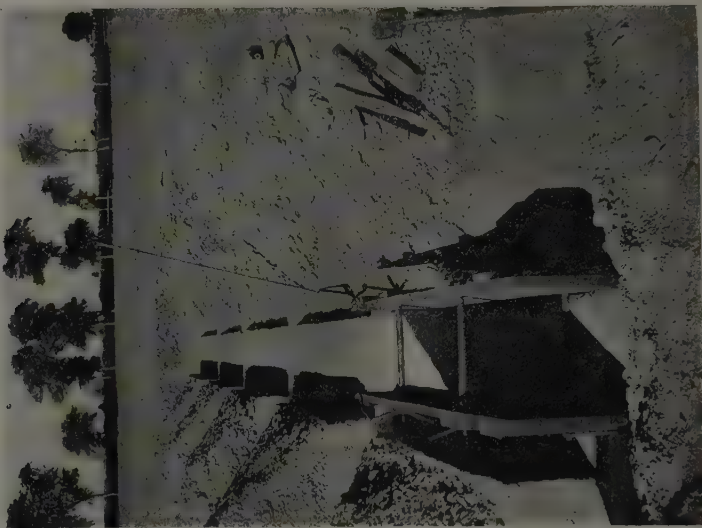

FIG. 2—A mould in position

FIG. 1—Foundation ridge

FIG. 3—Mould with end-plank

FIG. 4—Ramming

FIG. 5—A *pisé* block

FIG. 6—Showing method of sloping blocks for joints

Cover the two bottom distance rods which are resting on the foundation ridge with some of the prepared soil. Ram it well, adding more earth as required, until both rods are embedded in blocks of earth. This is extremely important, as if ramming is started all over the mould to commence with, the mould will gradually creep upwards as the ramming continues. If the bottom distance pieces are first covered and rammed well, the mould will remain firmly anchored to the foundation ridge. After the bottom distance rods have been firmly fixed in this way, spread a layer of prepared earth, four to five inches deep, evenly over the bottom of the mould. Ram this well, until the rammers leave no impression on the earth. Pay particular attention to the edges of the shutters and the end-plank, by ramming with the half-round rammer. Continue to add four to five inch layers of earth, ramming them as above, until the top of the mould is reached. The rammed earth at the open end of the mould is finished off as a slight slope (Fig. 6), as this makes a better joint than a straight end when the next mould is filled. The shutters can be removed immediately the ramming is finished. The two upper distance rods and the bottom rod nearest the sloped end of the earth block, may be left in the wall for use with succeeding shutters.

Next clamp a mould on to the foundation ridge of the other wall, pressing the ends of the shutters close up to the overlapping portion of the earth block already made. No end-planks are necessary in this case. Fill and ram as before. When the mould is removed, two earth blocks at right angles, forming the angle of the wall, will be in position. A mould can now be set up at each end, overlapping the slopes of the earth blocks, and a third mould can be set up on the blocks already built, to commence the angle of the second course. This mould should be clamped on to the second earth block which was made, overlapping the end of the first block. A round corner end-plank should be used. Alternate courses should overlap in this manner at the corners, to dovetail them for greater strength. As soon as the shuttering for the first block of the second course is taken down, four moulds can be brought into use simultaneously, and the work will proceed very rapidly.

The holes from which the distance rods are removed should be filled with loose earth, tamped well home with a small wooden rod.

The walls should be allowed to dry out for about fifteen days before they are finished off with plaster. Ordinary *lepai* (mud) plaster, such as is used for *kacha* (sun-dried brick) walls, will do, and a coating of coal tar will render it impervious to the weather.

The most vulnerable part of these walls is the top, which should be well finished off. Driving rain has little effect on the sides of the walls if they are properly plastered, but water percolating through the top of the wall can do a lot of damage. If desired, the top of the wall can be finished off with a few courses of burnt bricks in lime, which should include a drip course. Should something cheaper be desired, round off the top of the wall with mud and plaster it, giving a final coat of coal tar if ordinary country plaster is used.

Conclusion

Walls of this description can be made for about Sh. 1,950 a mile, entirely by unskilled labour, supervised by an ordinary mason to use the plumb-line to keep the moulds upright. This estimate includes the cost of maintenance of a pair of bullocks to plough and cart the soil and also cart water to the site. This shows a tremendous saving on Public Works Department estimates for brick walls, which work out as follows:—

(*a*) Burnt brick in mud with cement pointing: Sh. 15,840 per mile.

(*b*) Burnt brick in mud, but without cement pointing: Sh. 11,880 per mile.

(*c*) Sun-dried bricks in mud with 7½ in. top course of burnt brick: Sh. 5,445 per mile.

The most important point, which is really the whole secret of *pisé de terre* building, is good ramming. If soil of the right consistency is used, in shallow layers as described, and the ramming is well and truly done, very durable walls and buildings can be made.

Should cracks appear in the blocks a few days after they are finished, it is a sure sign that the percentage of clay in the soil is too high, and should be reduced by blending.

I have been asked whether white ants will damage these walls. I can only say that over ten years ago about fifty feet of wall, with no foundation, was built here. It has remained totally exposed to the weather ever since, and irrigation water often flows right up to its base. There is no sign at all of the presence of white ants. A few weeks ago a small section was cut out (after considerable heavy labour with pick-axes) and the interior of the wall was found to be almost as hard and solid as rock, with no signs of white ants or other damage.

NATIVE HONEY PRODUCTION FOR EXPORT

By W. V. Harris, M.Sc., A.I.C.T.A., F.R.E.S., Entomologist, Tanganyika

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Introduction

The importation of honey into the United Kingdom rose from an average of 1,300 tons per annum over the five-year period 1910-14 to 16,000 tons in 1918, owing to war-time restrictions on the use of sugar. The price of honey rose with the increased demand. After the war the quantity imported dropped to 2,650 tons per annum over 1920-24, rose to 3,950 tons during the next five years, and has continued to rise ever since. There are already indications that the demand is increasing during the present war. Normally, the price of honey is linked with that of sugar, with an Empire preferential tariff of seven shillings per cwt. over honey of foreign origin. Roughly fifty per cent of the honey on the United Kingdom market comes from Empire sources, notably New Zealand, the West Indies, Canada, and, to a less extent, Palestine. Other sources include the United States, the non-British West Indies, and Russia.

Potential local production

The wild bee population of Tanganyika is large. It has been studied in detail with regard to wax production, and for further particulars a pamphlet entitled "Bees-wax," shortly to be published, should be consulted. It would be misleading to correlate wax production with that of honey too closely, as the aims are to some extent antagonistic. Beekeeping for honey is designed to keep wax production down to a minimum, as bees require ten or more pounds of honey as food in order to produce one pound of wax. Modern methods directed to getting all the honey possible out of the bees have reduced the proportion of wax to honey produced in the United States of America from 1 to 17 in the middle of last century to 1 to 68 nowadays. On the other hand, the aim in the greater part of Tanganyika is almost exclusively wax, mainly because of transport difficulties. Wax makes a durable, easily managed head-load which, at two shillings a kilo, can be carried for many miles at a profit with no extra outlay for a container. Honey is much less valuable, less easy to carry, requires a container, and is perishable. Thus wax-producing areas in the Southern Province and the outer limits of the Western Province, for example, are not likely to be interested in honey. There is, however, a considerable internal trade in honey already in existence in the Tabora, Kahama, Manyoni and Dodoma districts within easy reach of the railway, which could be developed further for export purposes. Honey suitable for European consumption is hardly likely to be obtained in quantity in the coastal plain area, owing to the presence of old Ceara rubber plantations and a number of indigenous weeds which give honey a very bitter flavour. On the coast itself, good honey is obtainable in many parts—for example, in the mangrove swamps of the Rufiji—but the coastal native is hardly likely to interest himself in its collection. The finest honey is produced in the highlands of Ufipa, Iringa, and Usambara, but for a number of reasons the quantity available is small.

The quantity of honey in a hive fluctuates greatly, depending on nectar flow in the vegetation of the district, swarming and other factors, whereas the quantity of wax increases as time goes on. The wax collector can suit his own convenience, and, for example, wait until the grass fires have made walking through the bush easier. The honey collector goes out when he knows the hives are full of honey, or even when he knows that the honey from a particular source is ready. (The Nyamwezi prefer *Isoberlinia* honey for beer-making to the later *Brachystegia* honey.) Thus, although the proportion of wax to honey in a piece of full honeycomb is approximately 1 to 24, so much of the comb is empty during the wax-collecting season that the hive yielding 1 lb. of wax does not give 24 lb. of honey. Nevertheless, there is a large amount of honey available, even though a reliable estimate of the quantity is not, and it could be increased by simply taking the comb at an earlier date than at present. In Egypt the average production of native hives is just over 2 lb. of honey per annum, and in Palestine from 3 to 6 lb., according to the season. This is, of course, surplus to the needs of the bees, and does not result in the dissolution of the colony, as is usual in Tanganyika.

The nature of honey

Honey is derived from the nectar of flowers. Nectar consists of from 70 to 80 per cent of water. It is collected by the bees and stored by them in the cells of wax comb within the hive. Ferments added to the nectar during its

transport in the bee's stomach act upon the sugar, and produce the simpler sugars, levulose and dextrose, while evaporation reduces the water content down to about twenty per cent. Then the bees seal over the honey cells, and the honey, as it now is, is in a fit condition for storage. Ripe honey consists approximately of 20 per cent of water and 72 per cent of sugar, the balance being made up of dextrin, mineral salts and nitrogenous matter, such as pollen. It has a density of 1.412 (42.5 degrees Baumé) at 68 degrees F.; that is, one gallon weighs 14 lb. An increase in water content or a rise in temperature reduces the density. As water content is of primary importance in storage of honey, it is necessary to keep a check on density.

Native methods of production

The usual procedure adopted by the native honey-collector is to break the honeycomb into small pieces and to warm it in a cooking pot to make the honey flow easily. Then the mass is squeezed in a long grass bag and the honey collected in a vessel below. In the absence of a grass bag for straining, the comb is heated above the melting point of wax, and then on cooling the wax solidifies on the surface of the honey. It follows that with the indiscriminate removal of comb from the nest, not only capped (ripe) honeycomb is taken, but also uncapped (watery, immature) honeycomb, comb containing the bees' store of pollen and grubs, and, if the nest is an old one, comb which has become black with age and accumulated hive residues. The honey resulting is full of nitrogenous matter, and is made darker than necessary by contact with this extraneous matter. It is then run into gourds or old petrol tins without further treatment. The discriminating honey hunter, usually with a retail market in a township among Europeans, Indians and the brewers of the better types of native beer, separates his honeycomb from the broodcomb and any comb which is particularly dark coloured before squeezing out the honey, and often does this without a preliminary heating, thus avoiding the destruction of the aroma by accidental overheating.

Colour

Colour is of primary importance in honey intended for the United Kingdom market. Most of the Tanganyika honey comes from *miombo* (*Brachystegia-Isoberlinia*) woodland, and is naturally of rather a dark colour. Heating honey over an open fire almost inevitably makes the colour darker, because a small portion in contact with the hottest part of the vessel will become caramelized. Further, the heating of honey in contact with dark comb, as mentioned above, is a further source of increased coloration. Plain dirt and foreign particles are less important from the standpoint of colour, as they can be removed by filtration. Honey from the cloud-forest zone is amber colour, and that from the *Protea* grasslands is very pale. On the whole, however, native honey is very dark in colour.

Storage

Subsequent treatment of native honey should be directed to the avoidance of the two major problems of honey storage—fermentation and granulation. Fermentation is caused by the action of yeasts, which break down the sugars. These yeasts are normally present in all honey, but they are kept in check by high sugar concentration (i.e. minimum water content) and low protein content. Native honey tends towards a high water content owing to the use of uncapped, immature honeycomb. Also protein content is high owing to the presence of much pollen and particles of bees and grubs. As a general rule, it will accordingly be necessary to process native honey before storage or export, to obviate the risk of loss by fermentation. First of all the honey will require to be heated in a water-jacketed vessel or by means of a steam pipes to a temperature of 130° F. and maintained there half an hour to destroy all the yeast cells. This results in a slight loss of flavour, depending on the care with which it is carried out. Then the free-flowing warm honey has to be filtered through a coarse wire gauze to remove particles of bees, etc., and then through cloth of the texture of butter muslin. This should remove most of the impurities that would detract from the appearance of the honey and aid fermentation if reinfection by yeasts should take place. The filtered honey should now be stored in open tanks to allow air bubbles to rise to the top and form a scum with any particles of foreign matter that have passed the filter. It also permits of the evaporation of further moisture. Excessive moisture should not be removed by continued heating or the honey will be "cooked" and lose its typical flavour. When ripened in the tanks, the honey is run off from taps set a little above the bottom of the tank into containers, and sealed up.

Granulation is caused by the crystallizing of the dextrose fraction of the honey sugars. This results in an excess of water being added to the liquid portion of the honey and in the increased danger of fermentation. Coarse granulation renders subsequent handling difficult, and the additional expense of re-heating is incurred. Unless granulation is controlled so that the crystals are very fine, and the honey remains of a more or less creamy consistency, it is preferable to avoid it altogether. This can be managed by careful filtering to remove all foreign particles likely to act as nuclei for crystal formation, and by heating to re-dissolve any primary crystals that may have formed already.

The preparation of a small plant for the preparation of native honey for export should not be difficult, bearing in mind the necessity for cleanliness, avoidance of overheating, efficient filtration and adequate accommodation in the settling tanks.

PRICKLY PEAR ("CACTUS") IN SOUTH KAVIRONDO

By W. O. Sunman, B.Sc. (Agric.), Dip. Agric. (Wye), Agricultural Officer, Kenya

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Muhoru, a small location of some 2,000 inhabitants, a branch of the Abasuba tribe in South Kavirondo District, consists for the most part of a long peninsula jutting out into Lake Victoria, close by the Kenya-Tanganyika border. The peninsula is irregular in outline and in structure, with some rocky hills, surrounded by low sandy slopes ending at the water's edge in a fringe of papyrus swamp. The climate is hot, and the light sandy soil is subject to long periods of drought, although normally the seasonal rains are sufficient to produce adequate crops of eleusine and sorghum and also to raise some cotton.

About 1928, a local man returning from a visit across the border brought back some prickly pear "leaves" and planted them round his homestead. The prickly pear [probably *Opuntia Dillenii.*—Ed.] found the climate and soil of Muhoru very suited to it, and it established itself with ease. Its prickly nature and its rapidity of growth appealed to the Muhoru people and many took leaves and surrounded their own homesteads with it.

When the location was visited by the writer in June, 1939, it was at once evident that the prickly pear had obtained such a hold on the peninsula that it constituted a menace to the future welfare of the people. The homestead hedges had grown luxuriantly and the original lines of planted leaves had become great impenetrable thickets up to eight or nine feet across. Entrance gaps and the space inside the hedges were becoming encroached upon and the plants themselves were flowering and branching profusely. Figure 1 shows a fair example of the kind of growth. It may be noted that the usual hedge in this country consists of *Euphorbia* sp. (vern. *odjuock*) together with sisal (a later introduction) and to a lesser extent sansevieria and aloes.

In baraza with the chief and local elders the matter was discussed and the danger of permitting unrestricted growth of prickly pear was stressed. The people agreed that they had seen how rapidly it encroached on the land, curtailing homestead space and grazing, and described how both they and their cattle were subject to frequent festering sores through being wounded by the spines. They agreed indeed that they had for some time realized that the "useful" hedge was becoming a distinct menace, but they found it individually impossible to keep it under control. They readily saw that complete eradication was the only sure method of control and agreed that as soon as the cereal harvest was over, they would conduct a vigorous communal campaign upon it.

In due course the work was started and was organized by the chief with the assistance of the agricultural instructor. It was arranged that in the case of very large hedges the first cutting should be done communally, the owner being responsible thereafter for the burning and subsequent cutting as required. In the case of smaller hedges individual owners should tackle the work themselves.

It was soon found that to attempt to cut down big hedges with a knife or *panga* led to the cutter being severely scratched, and the chief devised a simple tool somewhat resembling a pole-axe; it consisted of a local heart-shaped hoe (the usual digging implement) worn or ground to a straight hedge and bound to the end of a long pole (see Figure 1). With this tool the thickest hedges could be cut

FIG. 1

FIG. 2

FIG. 3

down without danger. Workers complained not only of damage from spines but also of headaches and have described how they have found it necessary to work on the windward side of a hedge and to work only in the early morning. This is possibly due to nasal irritation from the extremely small spines that grow in tufts at the base of the larger ones.

It was soon found that mere cutting was of little lasting use and attempts were made to burn the cut plants. The country is but sparsely supplied with trees and the fuel adopted was cattle dung supplemented by such sorghum straw as could be spared from the home firing. Even burning was only partially successful as the naturally succulent leaves resisted fire and started growing again after a few days. Successive cutting and burning, however, was found effective, and when the writer next visited the area, in November, 1939, he was able to see some parts of old hedges completely cleared, the final stage of all being to dig up the charred stumps, some of which were two feet round, and to prepare the land for annual crops.

Figure 2 shows a hedge once cut and burned, growing again vigorously, and shows also the chief and his two sub-headmen who organized the work, and Figure 3 shows a section of hedge gradually being destroyed by successive burning and cutting, and also a section entirely cleared. The owner, shown also in this plate, described the arduousness of the work, but expressed his satisfaction that he had at least cleared part of his large hedge completely to the ground.

From Muhoru, the use of prickly pear as a hedge has already spread to the neighbouring locations of Suna, Kadom and Karungu, and here also the natives are working at its eradication. Prickly pear cannot be eradicated in a day, and while some clearing has already been completed, it will probably take two or three years before the area may be said to be free again.

It is of interest finally to recall that although the local people realized the disadvantages of prickly pear and the menace of its spread, it needed the encouragement of Government to bring them to do something about it. Once this encouragement was given, however, the whole of the work has been done by the people themselves under the direction of their chief.

GRASSES AS INDICATOR PLANTS IN UGANDA—I

By A. S. Thomas, B.Sc. (Hort.) (Lond.), M.Sc. (Reading), A.I.C.T.A.,
Department of Agriculture, Uganda

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In the January number of the East African Agricultural Journal there is a most valuable article by Milne on "Soil and Vegetation [1], in which he refers to the question of "indicator plants" and rightly says, "what most of them could tell about the soil is quite insufficiently known". Reference is sometimes made to the value of bracken (*Pteridium aquilinum* Kuhn) as an indicator plant; it is said to denote acid soil, suitable for tea planting. It seems, however, that the growth of the fern is rather an indicator of conditions of humidity: wherever the plant is abundant the climate is suitable for the growth of forest and therefore of tea. In Uganda it has been noticed that bracken often indicates poor soil; this species and many other ferns are especially abundant in the Sese Islands, where the rainfall is heavier and the soils are poorer than in most other parts of the country. Wardlaw [2] has pointed out the same phenomenon in St. Lucia, and has explained the dominance of ferns on derelict banana lands as a sign that the soils are too impoverished to support the growth of higher plants.

When plants are studied in the wild state much information may be obtained concerning their requirements in cultivation; for example, observations on the growth and habitats of wild Robusta coffee in the Uganda forests have thrown light on the problems of selection and culture of the crop. Similarly, if we are to regard grass leys as an integral part of our systems of farming, a great deal of information concerning the habits and value of different species may be gained by a study of natural grasslands. Grasses are eminently suited for study as indicator plants. As Edwards has pointed out [3], these already have been used to map out Kenya into zones of distinct types of vegetation, and these zones demand different management if they are to be utilized to the best advantage.

Before the grasses can be used for ecological studies, they must be named and classified correctly. In Uganda there has been a succession of people especially interested in grasses and they have contributed thousands of specimens to the herbarium at Kawanda. Yet, in spite of all the material that has been collected and determined (over four hundred and fifty distinct species and varieties of grasses have been recorded from Uganda), every year, new records are obtained and new species are by no means infrequent; not only are these new records obtained from the outlying parts of the Protectorate, but even the grasses near Kampala are not completely known.

The classification of grasses is difficult on account of the varieties inside the species. For example, a few years ago there were planted at Kampala cuttings of fifty different patches of what is called in Uganda "French grass" (*Cynodon Dactylon* Pers.), and all of them seemed to differ in one or more characters—in rate of growth, in the length and width of leaves, in the size and shape of the panicles, and in the degree of pigmentation of all parts of the plant. In fact, in Uganda, it is possible to obtain a range of forms of this plant which, under ordinary conditions at Kawanda, will vary in height from about two inches to two feet. It is impossible to say where the division between the two species, *Cynodon Dactylon* and the larger *C. plectostachyum* Pilg. (Star grass), would lie. If these are distinct species, it is probable that some forms are interspecific hybrids.

In some cases the morphological and physiological differences between the varieties of a species may be so important as to produce great differences in their economic value. If the different forms of *Cynodon Dactylon* are planted as lawn grasses and kept closely mown, some forms persist better than others; usually the smaller types prove to be the most long lived. *Setaria sphacelata* Stapf and Hubbard, a species widespread in Uganda, exhibits variations of great economic importance. Some forms appear to produce a much greater bulk of herbage than others. The types common around Kampala are upright in habit, tending to become tufted when heavily grazed, but a variety from Teso spreads underground and will form a fairly even sward.

The differences in the vegetative parts of plants intensify the difficulty of identifying them when they are not in flower, but it is essential that this should be done before saying definitely what species are present and what species are absent. Buxton [4], with the aid of an admirable series of photographs, has shown how greatly the aspect of a patch of African bush will alter throughout the year; species of

which no trace can be seen above ground will suddenly appear. This seasonal appearance and disappearance is especially marked in the case of grasses, as I know from personal experience. I have returned on two occasions to the spot where I collected a grass (a new species) in order to procure more material, but, as I could not recognize the rootstocks, I have been unable to find it again, although at the time of the original collection I noted that it was locally dominant. On this account it seems to be very unwise to make any definite statements about any grassland in Africa on the strength of a single visit; at another season of the year the composition of the herbage may seem to be entirely different. Incidentally, it is remarkable with what facility members of pastoral tribes can identify grasses soon after they have been burnt, just as the young leaves commence to show. The names given to the grasses, however, usually refer to their grazing value, not their botanical affinities—one name may be applied to several species, even to members of different genera.

Grazing also will greatly alter the appearance of grassland; even if the concentration of stock has been relatively slight, the animals may have eaten down all the more palatable valuable grasses, leaving only the coarser tufted kinds. The effects of heavy overgrazing in Uganda are well illustrated and described by Fiennes [5], but he is unfair in referring to the grasses as "weeds". It is my opinion that if 20,000 cattle are confined to an area of 500 acres for two or three months, one should be deeply grateful to any grasses which continue to grow under such conditions and should not condemn them as causing soil erosion. Fiennes does state that "the condition has in part been brought about by considerable overgrazing," but no mention is made of cattle treading the ground, although it seems obvious that the conditions he describes—the formation first of runnels and then of gullies—are due more to the disintegrating action of cattle hooves than to the tufted habit of *Sporobolus pyramidalis* Beauv. His statement that "*Cynodon Dactylon* may cause bare patches to appear in the pasture; this it does by spreading laterally in the rains and again receding during the dry season" also requires modification, for *Cynodon* is one of the most drought-resistant grasses in Uganda and, unless it is heavily grazed and trodden, the stolons form a protective cover over the soil; even if the leaves are withered in very dry conditions, new growth starts from the nodes at the onset of the next rains. The value of *Cynodon* in this respect is well shown in North Karamoja, the driest part of Uganda, where by the spread of tsetse-fly into areas which formerly were overgrazed the cattle have been driven away and the cover of grass has reappeared. In this area *Cynodon* is noticeable as being the first species to colonize the former kraal sites and well-trodden pathways, where no other grass will grow.

Slight grazing will alter the appearance of grassland, but prolonged heavy grazing will alter the actual composition of the herbage. The general aspect of the whole of Karamoja affords an excellent example of the effect of continued overgrazing in altering the vegetation of a district; not only the growth of grasses but also that of the woody plants has been greatly modified. Karamoja, which is situated in the north-east of Uganda, has a rainfall of about thirty inches, but the distribution is very erratic and a high proportion of the total precipitation is in the form of heavy storms. In addition the district is swept by strong, dry east winds from the Turkana district of Kenya, and sometimes the sky is darkened with dust storms from that area—vivid examples of what may happen in Karamoja if the soil cover is depleted any further. Much of Karamoja is flat, consisting of plains of "black cotton soil" from which arise isolated hills; the east of the district, on the edge of the escarpment above Turkana, is of more broken country.

In the west of Karamoja natural water supplies are deficient and large areas are left almost ungrazed; in such places there is a stand of grasses, about six feet high, in which *Hyparrhenia dissoluta* Anderss. and *H. rufa* Stapf. are the most important species. Nearer the rivers and water-holes, where there has been more grazing, the composition of the grassland is altered. Other, shorter species appear, of which the most typical are *Themeda triandra* Forsk. on the higher, well-drained ground, and *Setaria* sp. (cf. *S. sphacelata*) in the hollows where the soil is waterlogged in the rainy season. In the east of the district, especially near Moroto Mountain, where there are permanent water supplies and a heavy concentration of stock throughout the year, in the hollows there is a sparse cover of woody tufts of *Pennisetum* sp. (cf. *P. stenorrhachis* Stapf and Hubbard) and other grasses, but on the higher ground the grass cover has been completely destroyed. A few ephemerals such as *Aristida* sp. may appear in the rains, but much of the ground is bare or is covered with unpalatable plants such as a spiny *Barleria* (cf.

B. diacantha Nees) and succulent plants (*Euphorbia* sp., *Aloe sp., Sansevieria* sp., etc.).

Not only does the herbage change with increased grazing, but so does the growth of trees and shrubs. In the open ungrazed areas of the plains are relatively few trees, but on the slopes of the hills the grassland merges into what Phillips has called "Combretum—other species Open Woodland" in Tanganyika. As the intensity of grazing increases, so does the frequency of woody plants; in the hollows *Acacia drepanolobium* Harms. and *A. Seyal* Del. become common, while on the slopes other Acacia species (e.g. *A. pennata* Willd., *A. Senegal* Willd.) appear. Finally, in the areas of prolonged overgrazing, there is a thicket of *Commiphora* sp., *Acacia* sp., *Dichrostachys glomerata* Chiov., etc., closely resembling Phillips' "Deciduous Scrub Climax" [6]. Similar alterations have been produced by overgrazing in the drier areas of Kenya, as described and illustrated by Pole-Evans in his report [7].

There is much evidence in Karamoja to show that this last association should not be regarded as a climax community in that district, or, in ecological terms, that it is not an "association" but is an "associes". The plant community appears to be dependent upon continual overgrazing; it has developed around Mount Moroto, but has not done so near Mount Kadam to the south, or Mount Morungole to the north. There do not appear to be very marked differences between the soils and climates near the three mountains (once the soil cover has been destroyed, the effectiveness of the rainfall of course is greatly diminished), but there have been great differences in the population of stock around them. While there has long been a large concentration of cattle, sheep and goats on and around Mount Moroto, until recently there have been few near Mount Kadam and Mount Morungole, on account of inter-tribal disputes and raids. Moreover, as mentioned above, some areas in North Karamoja, which formerly carried much stock, have now been abandoned on account of the spread of tsetse-fly. In such areas the evidence of overgrazing is still abundant—the gullies, the patches of scrub and the old kraal sites still partially bare—but a good cover of grass has appeared in two or three years; succulent plants such as *Aloe* sp. are still growing mixed with the grass, but it is not certain whether they will continue to flourish in competition with a tall grass cover. Probably the woody species may continue longer, now that they are established; for example, *Dichrostachys glomerata* is widespread throughout grasslands in Uganda, and is a plant which usually indicates former kraal or house sites.

Grazing, treading and burning are the three operations by which the natural vegetation is most influenced by pastoral tribes; clearing, cultivation and burning similarly are the main processes by which agricultural tribes after the natural flora. With the exception of the swamps, the relatively small areas of virgin forest and some of the mountain grasslands, all the vegetation of Uganda has been influenced to a greater or less degree by man and his stock, and allowance must be made for this effect before considering vegetation in relation to the factors which usually are considered to be of prime importance in ecology—climate and soil.

Moreau [8] has shown how difficult it is to classify from the biological aspect the climates of East Africa, and that the normals should not be the sole basis; attention should be paid to extremes. Even if the climate of the various zones of Uganda could be defined in suitable mathematical terms, it would be very difficult to allot each species of grass to a certain range. The mountain grasses (*Poa* sp., *Festuca* sp., etc.) form a distinct group, and some of the tropical grasses have a restricted climatic range; for example, *Axonopus compressus* Beauv., a widespread tropical grass, in this country only flourishes near the shores of Lake Victoria—nowhere else in Uganda do conditions seem to be moist and warm enough for it. Other grasses, however, in their different forms can be found under very diverse climates; for example, *Setaria sphacelata* occurs in almost all parts of Uganda, from cool moist mountain grasslands down to the hot dry plains of the east and north.

In the matter of soils it is possible to make more definite statements. A number of species are known which are indicative of good soils, and a number which are usually confined to poor soils. Michelmore [9], in an interesting description of African grasslands, has brought forward the theory that seasonal flooding or waterlogging is the chief cause of open grassland as opposed to forest in tropical Africa. My own detailed studies in East Africa have been confined mostly to Uganda, where Michelmore admits that the theory must be modified, and my observations and conclusions in many matters are the reverse of those put forward in Michelmore's paper. The countryside near Kampala is characterized by forests

in the swampy valleys, above which is a zone of farms and Elephant grass (*Pennisetum purpureum* Schumach.), which, as mentioned below, is indicative of conditions suitable for forest growth, while short open grassland is confined to the slopes and tops of the hills. Michelmore does not consider that physical and chemical soil differences, apart from waterlogging, are of importance in determining the presence or absence of trees, but suggests that chemical richness may be the cause of the scarcity of trees. Little evidence is brought forward in support of this statement, and in Uganda the contrary is the case. Almost invariably, when forest and grassland are contiguous, the soil of the forest is richer than that of the grassland. It may be that the degradation of the soil has been due to clearing and burning, which has upset the balance of chemical and biological processes in the soil, as described by Milne [1] in Trinidad and by Lebrun [10] in the Belgian Congo, but, except in the cases where tree growth is inhibited by heavy grazing or frequent burning, it is obvious that the grassland persists largely because the soil is too poor to be invaded by trees.

The hollows in areas of orchard country which are liable to seasonal flooding often are quite treeless, but even there the lack of trees may not be due entirely to their intolerance of waterlogged conditions. Such areas often are relatively infertile. The poverty of the soils is indicated crudely by their mottled grey colour, showing that they are poorly aerated and that much of their iron content is in the form of ferrous salts as opposed to the ferric salts in the redder, drier soils. The lack of aeration must have a very detrimental effect on the biological processes of the soil. Incidentally, *Themeda triandra,* which Michelmore cites as the most typical species of upland grasslands, in Uganda occurs in greatest profusion on well-drained slopes in orchard country; like the *Combretum* sp. and other trees, it appears to be intolerant of prolonged waterlogging.

Continued observation is required before it is possible to assess the influence of climate, of soil, of man and stock on different grasses; the interplay of these factors may be exemplified by describing the distribution and behaviour of a few important grasses in Uganda.

Pennisetum purpureum (*Elephant grass*)

Dense stands of Elephant grass growing up to twelve or fifteen feet high dominate much of the uncultivated land in Buganda and Toro; that is, in those districts with a well-distributed rainfall of 45 inches or more a year, which lie between altitudes of about 3,000 ft. and 5,000 ft. Elephant grass occurs also outside these limits; on the eastern slopes of Mt. Ruwenzori the grass grows and fruits up to 8,000 ft., while it extends into the drier parts of the country along the edges of streams and swamps.

This species is of the highest economic importance to Uganda in restoring fertility to the soil after cropping. The manner in which it colonizes abandoned farms, two or three years after cultivation has ceased, has rendered it possible for the land north of Lake Victoria to support a dense population for a long period. For many years Martin has emphasized the bearing of soil structure in fertility, and has recommended grass leys on that account. Since 1932 it has been the policy of the Department of Agriculture to hasten the recovery of the soil at Bukalasa by planting Elephant grass, instead of waiting for it to come in naturally [11]. The growth of Elephant grass is greatly influenced by soil fertility; the richer the soil, the taller the grass. On patches of very poor soil it will not grow at all, but is replaced by other grasses (especially *Cymbopogon Afronardus* Stapf, described Part 2); such land is known as *lunyu*, and is avoided by the Baganda when making their farms.

Elephant grass will not stand heavy grazing; if the succulent young shoots are repeatedly consumed by cattle, it dies out. But this species will resist annual burning; in fact, burning appears to be responsible for its persistence in many places, for if the grass is protected for a few years it is colonized by seedlings of trees, which grow up and displace it. Wherever Elephant grass is found in quantity in Uganda, the conditions are suitable for the growth of closed forest. The most spectacular expanse of this species in Uganda is in Bwamba, on the western slopes of Mt. Ruwenzori, where it separates the equatorial forest of the plain from the mountain forests. But this stretch appears to be caused entirely by man-made clearing and firing. On the same slope, further south in the Belgian Congo, the equatorial and mountain forests merge one into the other without any intervening grassland. The whole volume of evidence goes to show that Elephant grass should be regarded as a stage of man-made degradation of forest—a stage of slight degradation, and one that is most convenient to agriculture.

REFERENCES (*see page* 53)

THE AMERICAN COTTON-GROWING INDUSTRY: SOME IMPRESSIONS—I

By H. R. Hosking, B.Sc., A.R.C.S., A.I.C.T.A., Botanist, Department of Agriculture, Uganda

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The writer of this article was fortunate in being able to travel from California to the Atlantic Coast of the United States of America during the latter part of the summer of 1938. During this journey, which was made entirely by road, the cotton-growing areas in the States of California, Texas, Louisiana, Arkansas, Mississippi, Alabama, Florida, Georgia, South Carolina, and North Carolina were traversed. In this manner a sectional view of the cotton-growing industry in the United States was obtained. Owing to limited time, which was further curtailed by the September crisis, it was not possible to study this industry as thoroughly as one would have wished. However, a certain amount of valuable information was obtained, and it is the intention of this article to place some of the impressions gained and the facts collected on record in readable form.

As one proceeds from west to east of the United States the cultivation of cotton appears to fall into the following natural categories:—

(i) The irrigated area in the San Joaquim Valley of California.

(ii) The rain-grown area of rather short-staple cotton in Texas.

(iii) The delta area of good staple cotton in the States of Arkansas, Louisiana and Mississippi, which lie on either bank of the Mississippi River in its lower reaches.

(iv) The Piedmont area in the States of Alabama, Georgia, the two Carolinas, and Virginia.

(v) The Sea Island area in Northern Florida and the southern part of Georgia.

The irrigated area in Arizona, where American-Egyptian (Pima) is cultivated exclusively, was not visited, as it would have entailed a large detour.

The San Joaquim Valley of California

In 1938 an area of 380,000 acres in the San Joaquim Valley produced over 410,000 bales of lint of 500 lb. each. The staple of this cotton, which is all of the Acala variety, varies from $1\frac{1}{16}$ in. to $1\frac{3}{16}$ in.; over 85 per cent of the crop falls between $1\frac{1}{8}$ in. and $1\frac{3}{16}$ in. The whole of this crop is saw-ginned, and the commercial ginning percentage is stated to be between 37 and 38 per cent. The average yield of the whole Valley over a period of years is approximately 550 lb. of lint per acre. This is equivalent to a yield of 1,447 lb. of seed cotton per acre.

As in all other areas where the staple is less than $1\frac{1}{2}$ in., the acreage is restricted each year under the terms of the Agricultural Adjustment Act of 12th May, 1933. The original purpose of this Act was to limit the acreage of the major economic crops grown in the United States to avoid over-production and consequent low prices; the prices fetched for these crops became too low for the farmers to grow them without incurring a loss. The crops to which this Act applied chiefly were cotton, maize (corn), tobacco and wheat. When the Soil Conservation Service of the United States Department of Agriculture was formed in 1933 it was soon realized that the terms of the Agricultural Adjustment Act were a valuable weapon to restrict the acreage under erosion-permitting crops and thus assist a nation-wide soil conservation policy. In 1938 the growers in the San Joaquim Valley were only permitted to plant 60 per cent of their 1937 acreage of cotton by the Agricultural Adjustment Administration, or as it is popularly known, the A.A.A. The A.A.A. pays to those farmers who abide by the acreage restriction a subsidy of two cents of a dollar (1938) for each pound of lint produced. If, on the other hand, a farmer is found to possess an excess over his prescribed allotment he has to pay a penalty of five cents on each pound of lint produced on his excess area. This penalty makes it quite impossible for any farmer to ignore the restriction imposed by the A.A.A.

The average precipitation in this part of California is only 9 inches, and all of this falls, either as rain or snow, during the winter months when there is no cotton in the ground; consequently the cotton crop has to depend

entirely on irrigation. The irrigation water is obtained from bore-holes, some of which are as deep as 2,000 ft., and electric pumps are generally employed to bring this water to the surface storage tanks. From the latter, the water is run to the fields by pipes. It is stated that the high cost of these pipes more than off-sets the water losses from evaporation which would occur if open furrows were used. The cost of irrigation water varies greatly, and depends mainly on the depth of the well. A fair average is said to be $4.00 per acre foot. The cotton crop requires 36 inches of water during its life, so the average cost of irrigation can be taken as $12.00 per acre. In certain parts of the Valley the cost of irrigation water is excessive, and only large-scale operators can carry on. Until the exceptionally heavy (a comparative term) rains of the winter of 1937 eased the position, the water table had been falling at an alarming rate. These rains resulted in the flooding of two dry lake basins. The Tulare Lake near Corcoran flooded about 40,000 acres of farming land, and at the Buena Vista Lake submerged farmhouses and buildings were seen. It is generally accepted that the water table will recommence its downward march unless exceptionally wet winters become more frequent or that the rate of pumping is greatly decreased. A further danger is in the quality of the water obtained from these wells; as the water falls so the proportion of chlorides and magnesium increases, until the water becomes unfit for irrigation purposes.

The yields, as has been stated above, are very high. With the exception of verticillium wilt and damage from capsid bug (*Lygus*), there are few pests or diseases. Owing to the absence of rain while the crop is in the ground, it only requires to be picked once or twice.

Picking is done by transient labour, chiefly people from the eroded areas of Texas and Oklahoma who are unable to obtain subsistence from their farms and who follow the harvests of the great variety of crops grown in California. A man is paid one dollar per 100 lb. of seed cotton, and the average picker turns in 300 lb. of seed cotton in a nine-hour day. In 1937 the winner of the State cotton picking competition turned in the incredible amount of 880 lb. of seed cotton after nine hours. A dozen of his competitors returned over 700 lb. each in the same period. When one considers the extremely high temperatures which rule during the time when the crop is ripening, these feats of physical strength and endurance become even more remarkable. The heat of the San Joaquim Valley has to be experienced to be believed. The shade temperature usually reaches a maximum of 115 to 120 degrees Fahrenheit during the maturation period of the cotton. In fact, it is stated that if these temperatures are not realized, then reduced yields will be the result. It is worth mentioning that throughout the cotton-growing areas of the United States higher temperatures are experienced and are considered essential for the good of the crop than in any of the cotton areas of tropical East Africa.

In normal years the value of the seed more than pays for ginning and baling. In 1937 the average value of the seed at the ginneries was $22.00 per ton (2,000 lb.). The average charge for ginning and baling for the period 1929 to 1936 was $5.33 per 500 lb. bale. So with a yield of 550 lb. of lint and 897 lb. of seed per acre, the farmer paid $5.86 for ginning and baling, and in 1937 would have received a balance of $4.01 after meeting this charge, because the value of his seed was equivalent to $9.87 per acre.

The value of land is very high in the Valley, and considerable capital is required to farm. The capital outlay for boring for water, installing pumps, storage tanks and pipes to the fields amounts to a sum which is quite out of the question for a small farmer to find. Furthermore, a small farm is not an economic proposition, under these conditions. The cost of one of the deepest wells of 2,000 ft. was stated to exceed $10,000. Therefore before one can draw up a true balance-sheet of the production of cotton, the interest on the very large capital required and the high depreciation on pipes, pumps, etc., must be taken into consideration. These figures were unobtainable, so only an incomplete analysis of the economics of cotton-growing in the Valley can be given (Table I).

Approximate expenditure and receipts resulting from an average acre of cotton in the San Joaquim Valley: 550 lb. of lint and 897 lb. of seed:—

TABLE I

Expenses

Cultivation and weeding	$14.00
Irrigation water	12.00
Picking	14.40
Ginning and baling charges	5.86
Interest on capital and depreciation	?
	$46.26

Receipts

Value of seed at $22.00 per short ton ..	$9.87
Value of lint at 10 cents per lb.	55.00
	$64.87
Plus A.A.A. subsidy of 2 cents per lb. lint	11.00
	$75.87

We can presume that the A.A.A. subsidy, which amounts to $11.00 per acre, would never more than counterbalance the interest on capital and depreciation. If this is so, then the maximum profit is in the neighbourhood of $18.00 per acre. It must be remembered that a considerable number of farmers will average yields below the mean of the Valley, and these would find it quite impossible to grow cotton without the A.A.A. subsidy. Again, those farmers who have been unlucky with their water supply and have had to put down wells of the maximum depth would also find it difficult to carry on without this subsidy.

The cotton farmers of California are practising monoculture, and, with few exceptions, are not practising a proper rotation. When the land will no longer give economic yields of cotton they move the irrigation pipes to another area. Before the new land is planted with cotton it is put into heart with lucerne (alfalfa). Subsequent cultivation is purely exploitative.

At the Shafter Cotton Field Station of the U.S. Department of Agriculture the usual rotation is two years of cotton followed by six months of bare fallow, then three months under cowpea and another six months' bare fallow while the ploughed-in cowpea is rotting. The land is irrigated before the cover crop is turned in, but no water is applied while the rotting is in progress. It was stated that a good alternative rotation is three years of cotton followed by three years under lucerne. In the past, lucerne hay fetched good prices, but lately the price has fallen and this has discouraged farmers from resting their land under lucerne after repeated crops of cotton. At this station the cotton is sown with a two-row continuous planter, with the rows 38 inches apart. The cotton is subsequently thinned to 12 inches between plants in the row. The seed rate is 35 lb. per acre, and considering the high value of seed this appears to be very liberal. It has been estimated that of the 36 inches of water applied the crop receives 27 inches and the remaining 9 inches are lost by evaporation in the field.

California is a one-variety State, but they are testing a number of varieties other than Acala at Shafter. The chief aim is to obtain resistance to verticillium wilt and tolerance to *Lygus*. Considerable progress has already been made in respect to wilt resistance. Mr. G. J. Harrison, the officer in charge of the Shafter Station, stated that under the conditions ruling in the United States staple of $1\frac{1}{16}$ will always find a ready market, whereas it is doubtful whether there is a permanent and ready market for $1\frac{3}{16}$ staple, and for this reason it may be necessary at some future date to reduce the average staple of the Valley crop from full $1\frac{1}{8}$ to $1\frac{1}{16}$, although at the present time there is a steady market for $1\frac{1}{8}$. If the staple was raised to $1\frac{3}{16}$, a temptation in view of the higher premium for cotton of this description, it might be found that the 400,000-odd bales produced each year could not all be sold. In normal times Japan has taken 95 per cent of the crop, but owing to the Sino-Japanese war she was unable to purchase anything like this amount in 1938. There is, however, an increasing demand for this cotton in the United States. In 1937, India purchased 60,000 bales in place of roller-ginned Uganda cotton. On 1st June, 1937, the value of Californian Acala was 13.85 cents per lb., but sixty days later, when the harvest began, the price slumped to 7.60, and under these conditions the merchants were able to offer this cotton to India at a low price. Mr. John Wright[1] states that the transport cost for baled lint to the western ports from the Californian ginneries was about 30 cents per 100 lb. of lint, and the ocean freight from thence to India about 60 cents per 100 lb. of lint. In the past the latter charge had been as low as 25 to 30 cents per 100 lb. The all-in cost of transport of lint from ginnery to India is in the neighbourhood of 90 cents per 100 lb., or approximately a halfpenny per lb. lint in English money.

[1] Senior Agricultural Economist, Cotton Marketing Studies, Division of Cotton Marketing, Washington.

SOIL CONSERVATION—THE RESEARCH SIDE*

By G. Milne, M.Sc., F.I.C., Soil Chemist, East African Agricultural Research Station, Amani

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Natural laws show that until the different kinds of land, dependent on soil character, slope, susceptibility to erosion, climate, and cover, are treated individually according to their needs and adaptabilities, success cannot be obtained with any programme of erosion-control. These differing parcels of land that go to make up a field, a farm, a watershed, the Nation, call for the use of all the knowledge that science and experience have accumulated, all the practical measures that have been devised. But that is not enough. We do not know enough. Successfully to combat accelerated erosion and waste of rainfall we must have a continuing programme of research to discover new methods, to improve old methods.

Russell Lord, *To Hold This Soil.*

Much is written nowadays in agricultural journals about the combating of soil erosion, both in regard to the urgency for it, and on methods. Rather little, comparatively, is said about the research background of soil conservation. Yet behind our present knowledge of the processes of accelerated erosion, and supporting what has been achieved in successful remedial measures, lies a mass of careful observation in the field in many countries. Arising out of this, and aimed at clarifying many questions of principle or of detail, a great deal of organized research has been started and is already fruitful. Besides these more general inquiries, investigation of the particular circumstances precedes, or should precede, each local soil conservation programme, as a necessary preparatory stage before actual measures are undertaken.

In this article I give an account, necessarily summarized and incomplete, of the investigational side of soil conservation as I saw it in the parts of the United States that I visited in 1938.

The total of inquiry that is in progress in this connexion covers a very wide field. Excluding those very fundamental investigations into possibilities of economic, social and even political readjustments that underlie the whole subject and which are engaging attention in the highest quarters in America, the technical questions that are being faced fall under one or more of the following heads:—

(1) The root causes of soil instability.

(2) The behaviour of soil and water, or soil and wind, in the field, as it can be studied quantitatively, whether on an experimental scale using small plots, or under more natural conditions on watersheds and larger geographical units.

(3) The devising of control measures and the testing of their effectiveness.

(4) Preparatory surveys.

In one or other of these senses, a great deal of the work of the American soil conservationists, besides that of their scientific colleagues, is of a research nature, though it may not be so designated. Object (3), control measures, and in a semi-quantitative sense object (2), the field behaviour of soil, naturally engage much of the interest of the Division of Conservation Operations, which is an executive and not a research branch of the Soil Conservation Service. Even though the scale on which the work is done gives some of their more commonly applied methods the appearance of having settled down to a routine basis, comparatively little of the practice of the Operations Branch has yet come to be regarded by themselves as standard. I almost always found that the field men of this Division took a critical attitude to their own work when demonstrating examples of it that had had the test of a few seasons' rains and droughts. This would be so whether they were engineers demonstrating concrete structures in Californian *barrancos*,[1] or New Mexican range management men showing how re-vegetation was working out, or Texas agronomists endeavouring to reduce the pressure of cotton and maize upon the fertile soils of the Blackland Belt. They were applying measures that would transform a landscape, but they looked upon their methods as experimental and were acquiring experience that might alter them.

This was to me an impressive feature of the immense total of effort and monetary expenditure represented by the work of the regional Operations staffs. In the form of their activities alone, research is being financed upon the very

* This article contains the substance of one of the chapters of a report recently rendered by Mr. Milne on a study journey he made in 1938 (with the assistance of the Carnegie Corporation of New York) to parts of the West Indies and the United States. Other articles deriving from the same source have appeared in the Journal for January, 1940 (Vol. 5, p. 294) and in that for May, 1940 (Vol. 5, p. 436).

[1] A *barranco* is a master gully or canyon-like stream bed, excavated by storm water.

grandest scale. One can hardly think of a parallel except in the scale of military spending in modern war, and the parallel is a just one, for the United States has been at war against soil erosion now for some years. An end has been made of cautious conversations and inconspicuous intelligence work; negotiation now is by means of armies. And if a battalion fails to take a position at the first assault—it is another entry in the laboratory note-book!

The survey work undertaken in preparation for soil conservation programmes starts, of course, with the general realization by many observers, lay and other, that it is time something was done in the area concerned; but the technical beginning is made with soil survey. For the principles and some of the methods on which this is carried out, the reader is referred to my previous article on soil survey in the May number of this Journal. Special devices are used on the maps for recording degrees of erosion, types of gullying if present, slopes, kinds of land use, etc., and a handbook of instruction is issued for the surveyors working in this branch. The scales of mapping vary according to the kind of country and its manner of occupation. Commonly it is 1 or 2 inches to the mile for open pastoral land, with a rate of mapping of 10 square miles per day by a party of two men. On agricultural land, 4 inches to the mile is customary, with a rate of progress of from 400 to 600 acres per day; but on certain arable ex-prairie lands in north-western Indiana, where by invitation I accompanied a field party, they were working at 8 inches to the mile, the rate of progress being assisted by air photographs being available as field sheets for the base map, so that the construction of a reference framework by plane-tabling was not necessary. On certain orchard lands in southern California a scale of 12 inches to the mile was regarded as necessary, the justification for that degree of detail being the high productive value of the unit holding.

Symbols of a sufficiently informative kind for conservation-planning on pastoral land can be applied to one-inch maps. Each compound symbol is written in fractional form, thus—

$$\frac{{}^{1}\text{Erosion, Land Use}}{\text{Slope, Soil}}, \text{ e.g. } \frac{\overline{3}\ (7),\ \text{P}}{6\text{B},\ 12}$$

The symbol occupies about a quarter of an inch of space, and so can refer to a minimum land unit of $\frac{1}{16}$ square mile, or 40 acres. But for cultivated land, the unit of land use (the field) may be much smaller than this, and the one-inch scale is too small for symbols to be used except at constant risk of over-generalization. At 4 inches to the mile, symbols a quarter of an inch broad can represent a minimum area of $2\frac{1}{2}$ acres. At this minimum spacing, however, they would of course overcrowd the map to the obliteration of other detail, hence the need for larger scales when minuteness of planning is called for on high-value lands.

It will be seen from this one example of mapping methods how carefully the technique of soil survey for erosion-prevention has been worked out. Surveys of other kinds are carried out similarly. Range examiners conduct herbage surveys, agronomists examine agricultural practice and cropping systems. Engineers make surveys of stream behaviour and look for materials available for construction. Foresters look into questions of woodlands and watershed protection. Biologists inquire into the numbers, appetites and behaviour of rodents and other animals that compete with man for the use of the land or disturb the soil by burrowing. There was a good story told against a biologist on the San Joaquim Experimental Range in California who was researching into the reproductive rates of squirrels—but in so discreet a Journal as this it is not printable. In the Navajo Indian Reservation in Arizona one of my technical guides was an anthropologist, who was employed with the Soil Conservation Service so that man himself should be duly included amongst the soil-influencing factors surveyed. In that area the standard composition of the survey party was Range Examiner, Soil Scientist, Engineer; the other specialists were attached as necessary.

One of the principal duties of a Range Examiner is to arrive at an estimate of stock-carrying capacity from a study of the grasses, herbs and browse plants and a knowledge of the feed requirements of the stock. Sheep being the principal wealth of the Indians of the south-west, the estimate is computed in sheep-units; 5 sheep units equal one horse unit, 4 equal one cow unit, 25 prairie-dogs equal one

[1] This compound symbol would convey the following information:—

Erosion.—Moderate sheet erosion, about half the original top soil gone, new surface now stabilized. Occasional gullies, uncrossable by tillage implements.

Land Use.—Pasture.

Slope.—Dominant slope of 6 per cent; would be suitable for arable use if proper control measures are applied.

Soil.—The numeral indicates the soil type according to a local list.

sheep. The figure adopted is the mean of a dry-year minimum and a moist-year maximum. The carrying capacity so arrived at is compared with the actual stock within the area, and in this way the amount of overstocking is expressed as a percentage of an approved safe stock population. A policy of annual reduction of the excess is then instituted until re-vegetation and other ameliorative measures shall have taken effect and the carrying capacity improves. Thus in the Navajo Reservation the total acreage is about 15 million acres; the safe carrying capacity has been reckoned as about 540,000 sheep units, the stocking is 720,000 sheep units (showing an excess of slightly over 25 per cent), and the total necessary adjustment for the area is a reduction of 180,000 head of sheep or their equivalent in other stock.

The carrying capacity of such dry country as this, only the highest-lying plateaux of which have a rainfall of as much as 20 inches, is only about one sheep unit to 28 acres. Its human population averages two per square mile. The great need, if stock reduction is to proceed without hardship and if the general policy of soil conservation is to win the assent of the tribe, is to increase the wool-producing efficiency of the sheep, so that smaller flocks can provide the Indian with his livelihood. A breeding programme to this end occupies the staff of a research laboratory within the Reservation.

Still higher degrees of overstocking are found elsewhere in this region, in the basin of the Rio Grande. Thus in the small Acoma Reservation, with a carrying capacity of 12,000 sheep units, the stock population was recently 22,000; in the Laguna Reservation of capacity 10,000, it was 60,000. Such pressures as these bring about an extremely bare condition of the land surface, and even after the problem of reducing the total grazing load has been put in the way of solution by the acceptance of a sliding-scale programme of stock-reduction by the peoples concerned, the technical difficulty of restoring productivity to the almost sterilized soil, under the prevailing very low rainfall, remains extremely great. Where the loss of vegetative cover has not gone quite so far, fencing for the temporary exclusion of stock is usually effective. The working system jointly composed of soil and plant, though mutilated, can still function, and its recovery gathers momentum. "The best tool for gully-healing is the three-wire fence," said one of my guides. In certain extreme cases, however, the method of stock exclusion fails, or at least is too slow to effect the saving of the soil, as there is little increase in herbage in several seasons. In spite of re-seeding and the skilful use of water-spreading devices, the land surface is kept so bare by wind that the soil remains a dead thing. The problem is now one of resurrection, a branch of miracle-working to which even the Soil Conservation Service has not yet fully applied itself.

Some of the techniques of re-vegetation, water-spreading, gully-healing by vegetative methods, and generally of the means of taking advantage of the reduced grazing pressure due to stock reduction, are under detailed investigation at an Experiment Station in this region (at Mexican Springs, New Mexico). A novel subject of research there by ingenious means is the effect of silt deposition on the grass cover of a bottom-land. Varying depths of silt are brought upon prepared plots of grass, by applying different amounts of turbid water. Flood water from overgrazed and eroding pasturage has a high content of silt, and the success of water-spreading in promoting grass growth of good stock-carrying capacity in such circumstances is dependent upon the ability of the grass species to survive burial under silt and grow strongly again to the new surface.

A new field in soil conservation research has been entered by certain members of the staff for Climatic and Physiographic Investigations. *The gully* is taken as the subject of study. Whereas engineers, botanists and others have studied gullies for the immediate end of stopping them by structures or the growth of plants, these physiographers are strong-minded enough to withhold all interference with the gullies they are studying, in order to watch them through their course of development (or natural stabilization, as the case may be) over a period of years. They institute thorough geological and soil studies, record the events of weather, photograph and measure the cross-sections and exposed faces, and endure torrential downpours or sit up on frosty nights in order to describe minutely the mechanisms of denudation. Some of the results are already available in a fascinating publication of the U.S. Department of Agriculture entitled *Principles of Gully Erosion in the Piedmont of South Carolina*. Not, be it noted, the principles of gully-*stopping*. This is a pure research into the life-history of gullies. Man enters into the matter only as an environmental factor ranking along with the physical ones.

From a day spent in the company of one of the participating scientists it seemed that the phenomena being studied in this way in the south-eastern States are effectively similar to the corresponding phenomena on substantially similar soils in some red-earth districts of East Africa. The chief features that differ are the operation of winter frost in the one region and of termites and the run-off from their mounds in the other. These admirably scientific studies of the Piedmont gullies are of great general interest. As regards the contribution they make to the soil conservation problem as a whole, a great part of their value lies in their exposure of the nature of the threat to good land lying in the catchment basin of an active gully. We may not ever regard land once eroded to the gully stage as being economically capable of restoration to normal productive use, at any rate not to its original use. We do, however, owe it to the sound land that is within reach of a gully system, to stabilize the dissected ground, with a view to preventing further headward cutting and ramification.

A further point that emerges very clearly is that in soils having a foot or two of comparatively erosion-resisting B-horizon (sub-surface material) overlying a considerable depth of rotten-rock C-horizon (subsoil) which may be very vulnerable material, the gully-to-be spends an unspectacular part of its life-history as a slowly-deepening rill which is apt to be despised as a thing of no menace. The treatment of the rill is neglected, but once the B-horizon is cut through, such a rill enters a violent stage of development by deepening and headward caving. The damage at once becomes severe and treatment much more difficult: devastation by bad-land formation is in sight. I would suggest that studies of gully life-history such as these, in relation to soil morphology, land-use practices and vegetative cover, are of an ultimate significance to East African agriculture at least as great as many a study of the life-history of an insect or fungus pest upon which equivalent technical skill, time and patience is expended with general public approval.

In several laboratories I encountered a continuance of work on a problem of great practical interest which has so far yielded somewhat confusing results to investigators, namely the relation of the physical and chemical properties of soil to erodibility. The difficulty of work on this problem lies in the number of factors that affect in the field the total property "erodibility". Some of these are not readily measurable or reproducible in the laboratory. Such factors include compactness, degree of drying before wetting by rain, the effects of living roots and root channels, insect burrows, the spaces between the larger units of soil structure, and the external factors of slope, cover and mode of action of the eroding water. Percolation rate under standard conditions, and "dispersion ratio," a figure obtained by comparing the results of a physical analysis after complete separation of all the soil particles with an analysis of a simple water suspension obtained by slaking the sample in quiet water, appear to be properties of some diagnostic value in predicting erodibility. This is a field in which an improving knowledge of clay constitution, and with it a better understanding of the root causes of the physical properties of soils, should clear up many apparent inconsistencies.

A decision that has to be taken on every occasion when the form of a piece of sloping land is to be altered by terracing or other physical obstruction to flowing water, is on the probable nature of the water balance-sheet as it may be expected to work out at times of maximum rainfall. Reducing the problem to general terms, we have to classify the case in one of the following categories:—

(A) A rain of the maximum expected intensity and duration will be absorbable, having regard to the nature of the soil, the slope, the kind of land use, and the measures we are to apply.

(B) The absorption of a maximum rain will be impossible, or is not desired,[1] and provision must be made for the safe disposal of the excess by surface drainage.

It is clear that a different lay-out of the proposed work is called for according as the decision is taken to classify the particular case as (A) or (B). For case (A), the design will be for the most efficient absorption, and the question of the disposal of surface water will not arise. For case (B), efficient absorption will still be an important feature, but questions will arise of channel grades, channel capacities, erodibility of channel floors, provision of outlets, final disposal of the water led off, and co-ordination of arrangements on neighbouring parts of the same slope.

[1] Cases occur where total absorption is possible but not desirable, on account of the risk of causing landslips.

Case (A) is much the simpler to deal with, but only arises in country of low customary intensities of rainfall, of moderate intensities combined with highly absorptive soil, or of high intensities combined with very efficient vegetative cover such as forest or grass sod. It can be handled by such means as contour furrows, contour banks and brushwood spreaders on pasture land, or by contour planting, strip cropping, ground thatching, hedging and simple forms of level terracing on cultivated land. The only quantitative aspects of the problem are such matters as the interval between obstacles, the strength of earthworks or the width of strips.

Case (B) is altogether more difficult and occurs more frequently. It requires estimates of the run-off that will have to be provided for, calculations of grades and capacities, and forethought in the safeguarding of outfall channels against scour or of lower-lying lands against damage by flooding and deposition of silt.

Inquiring whether it was possible to classify a given case as (A) or (B) by calculation from all the data after surveys were complete, I received the answer: "Choice of conservation practices is determined by soil, slope, crop, rainfall and intensity of rainfall. But a quantitative analysis of the weight of these factors, and the development of a formula to decide the choice, has not been attempted." In other words, many of the factors that affect the question "planning for total absorption versus planning for safe drainage" are being studied and are becoming better understood, but the decision in a given case remains a matter of experienced judgment rather than exact reckoning. Judgment that is not experienced, or that neglects to take note of the evidence that investigation can provide, may easily make mistakes. In well-known combinations of conditions much can be done by rule-of-thumb. But a reliable computation from the separate factors, such as would be especially useful in unfamiliar country or in borderline cases, is not yet possible.

Amongst the investigations that are contributing towards a general solution of such problems are those of the so-called Erosion Experiment Stations, where run-off and soil loss are measured quantitatively under known conditions of slope, soil and climate, and controlled conditions of plant cover. The run-off from the plots is measured, automatically recorded and sampled by ingenious devices, one of which is the Geib Divisor, which by two successive divisions of the run-off collects an accurate aliquot of the total, say 1/9th x 1/5th = 1/45th. By such means the personal error, and also the demands upon the staff for skilled attention to the experiments, are much reduced. At the Black Land Station, Temple, Texas, the experimental results are tested by field-scale demonstrations, one of which, on the subject of cotton, shows that down-slope planting of this crop is the equivalent of a severe gullying as regards the amount of soil loss it permits, though the damage may not be obvious to the eye. Thus cotton in down-slope rows had lost 57 tons of soil; an equivalent plot planted across the slope, in which a breach through a broad-base terrace had caused an ugly deep rill-system to develop, had lost 59 tons; whereas a strip-cropped plot had lost only 7 tons.

Certain soils of the cotton-growing districts of East Africa, notably in the Lake Province of Tanganyika, are rather closely related to the Houston Clay of Texas on which this demonstration was carried out, and the effect described is probably a general one on heavy soils.

At this same experiment station is an extensive collection of grasses which are being studied for their soil-holding and forage-providing qualities. A strain of Bermuda grass (*Cynodon dactylon* var. *maritima*, from St. Lucie) attracted my attention. It has a broad leaf and gives a good grazing yield, but is without the creeping stolons that limit the use of the *Cynodon* strains common in East Africa by making them bad weeds in arable land.

Watershed studies, i.e. stream-flow measurements combined with detailed observation of the corresponding catchment areas, are a further mode of approach to the general problems of absorption and run-off. At Waco, Texas, a considerable area of farm lands in rolling country has been surveyed and equipped with instruments in such a way that the yields of run-off water and silt can be measured from catchment areas of $\frac{1}{4}$ acre, 3 acres, 20 acres, 40 acres, 120 acres, 300 acres, and 4,000 acres. The unit in each case is a natural basin bounded by the low ridge-tops that form the drainage divides. At present the land is worked by the methods of the original occupiers, most of it in rotations of cotton, oats, cotton, sorghum. After some years of observation under this unimproved system, one-half of the area will be taken in hand for the control of erosion, and the observations continued.

Other forms of the same kind of experimentation, carried out more elaborately, are to

be seen at the San Dimas Experimental Forest in the San Gabriel Mountains east of Los Angeles, California. This is a research station on the grand scale, "dedicated to the pursuit of studies in the management of chaparral watersheds for the maximum yield of useful water and for other human benefits". The programme includes determinations of the consumption of water by scrub and dry forest vegetation, and by other types of vegetation that might be substituted for it. The installation includes a variety of stream gauges, silt-measuring devices and meteorological instruments of novel types, the readings from a large number of which, at stations distributed about the watershed, are brought electrically to a central laboratory for automatic recording. There is a formidable battery of 26 large lysimeters, each measuring 10 ft. x 21 ft. x 6 ft., supported over a catacomb of underground instrument chambers—evidently the Maginot Line of this particular war-front. The only doubt that disturbed one's admiration of this adventure in highly-organized research in the cause of soil and water saving was whether the master mind would be found that would be able to digest the mass of results accumulating daily in that electrical recording room, and extract meaning from them.

One of the interesting findings here, and it appears also amongst the observations of the Appalachian Forest Experiment Station on the other side of the continent, concerns "transpiration draft," or consumption of water by vegetation. The stream-gauges installed in drainage basins carrying a complete closed cover of scrub or forest show a daily variation of flow in dry weather, the flow being at a minimum in mid-afternoon and at a maximum about 8 a.m. The interpretation of this is that during the day the normal slow percolation of subsoil water to the stream channel is intercepted by the roots of trees and scrub to the extent of their transpiration needs, whereas at night no such demands are made upon it. In some cases the flow in the stream bed in times of drought was found to cease altogether each afternoon, but began again about 8 p.m.

I conclude by referring to my short visit to the Outdoor Hydraulics Laboratory of the Soil Conservation Service, at Greer, South Carolina. The station is located beside a small stream, from which flows of water of known rate can be tapped by means of a series of calibrated sluices and weirs. These flows, which can be adjusted between the limits 1½ and 30 cubic feet per second, are directed down vegetated channels of known grade in which various plant species are under test for their value in preventing scour in terrace outlets. Results are being obtained that are of direct interest both to the engineers and to the botanists who are engaged in soil conservation work in that region.

ANTI-EROSION MEASURES FOR RAILWAY PROTECTION

Above the railway between Kikombo and Igandu stations about 600 acres have been treated by means of broad based interrupted contour banks and gully stopping. The chief has given orders that all land cultivated there is to be put under tie ridges; and the area has been declared a grazing reserve. The railway at this point runs only a few miles below the watershed of the Rufiji and Wami river systems, and of recent years frequent washaways have occurred here owing to extensive new native settlements between the line and the watershed, which by their attendant factors of cultivation and overgrazing have made the soil highly susceptible to erosion and therefore to washaways at the first onslaught of the rains. The scheme has cost approximately £300, provided by the Railway Administration in order to demonstrate that protection of the permanent way can be effected by dealing with the source of the trouble at a fraction of the cost required for culverts, bridges, etc., while at the same time a large area of land can be reclaimed. This is the most important scheme of its kind yet attempted and if it is successful, as all who are concerned in it are confident it will be, it will revolutionize Railway policy with regard to the maintenance of the permanent way where it passes through eroded areas. Just before the year closed, the contour banks received the shock of the season's first rain storm. It was an exceptionally heavy storm, but though several of the banks broke the opinion was general that a washaway was averted.

Reference: Annual Report, 1939, Provincial Commissioner, Central Province, Tanganyika Territory.

IMPRESSIONS OF THE COFFEE-GROWING IN EAST AND CENTRAL AFRICA—I

By Dr. Hille Ris Lambers

[During the latter part of 1938 Dr. Hille Ris Lambers, of the Experiment Station at Malang, Java, made an extensive tour through the African coffee-growing districts. In the course of his journey he visited Lyamungu, Amani, Nairobi, Kitale, Kampala, Kawanda, Rutshuru, Mulungu (in Kivu), Irumu, Nioka (on the west side of Lake Albert) and Ganggala-Boja; and thence travelled south-west to Stanleyville and Yangambi, the main Experiment Station of the Institut Nationale pour l'Etude de l'Agronomie du Congo Belge.

The following impressions of his journey are extracted from an address given by him to planters' meetings in Java (De Bergcultures, Vol. 13, pp. 1800-1810, 1939), translated by Mr. R. E. Moreau. Certain points that seem to require comment are dealt with in footnotes by Mr. L. R. Doughty.—*Ed.*]

What struck me first was the lack, sometimes the complete lack, of shade in the coffee plantations. The *Leucaena glauca* so general here was not used, sometimes for fear of mealy bug, but also because *Leucaena* often will not grow in view of the soil conditions. Use is made of other trees, including non-leguminosae, and, in some areas, of artificial shade. This artificial shade is used in some districts where the rainfall is low, by no means adequate for both coffee and shade-trees, so that to avoid the competition of the latter artificial shade is introduced. Split sisal-poles are sometimes used, suspended at different distances with wire.

In the higher British and also Belgian districts certain physiological diseases occur, the harmful effect of which is increased when there is little or no shade. Among them I include in the first place the so-called "black tip" or "hot and cold disease" of the British Colonies, a symptom known in the Belgian districts as *brûlure*. The growing points of the branches turn black and die off. All the buds sprout freely and produce very thickset branches with little tufts of sickly leaves. This growth of branches proceeds at the expense of flower-bud formation, which is consequently sparse and defective. From recent experiments in British, and especially in Belgian, districts it is plainly evident that this group of symptoms is caused by sudden changes in temperature, and especially by the rapid transition from the minimum temperature in the morning, generally just before sunrise, to the high temperature that succeeds shortly afterwards. It is clear that this phenomenon can be reduced to a minimum if proper shade is provided. Now it has been established that in Arabica sowings plants occur with green terminal leaves and with brown or bronze-coloured ones. At the same time it was found that the "brown tip" suffered much less than the "green tip" from the disease. And this appears to hold good not only for this disease but also for overbearing symptoms, which lead to dieback of branches.

M. Stoffels, of the Mulungu Station in Kivu, has been able to escertain by experiment that the great variation in productivity of Arabica trees must be imputed to lack of balance between production and growth. Further, that the variability in production is greatest in the "green-tip" plants and least in the "brown-tip". The "brown-tip" plants also show themselves, as already mentioned, less inclined to over production and dieback and less sensitive to *brûlure*, to which 25 per cent of the coffee trees planted in Kivu succumb. Without shade, plantations of Arabica with "brown-tip" gave much better results than Arabica with "green-tip". The workers at Mulungu now have at their disposal a number of Arabica lines that show a high degree of resistance to *brûlure* and a moderately high production. Since the colour of the terminal leaf is already fixed at an early age, selection can be successfully carried out in the nursery beds.

In the matter of soil-maintenance much remains to be done in Central Africa. I often saw the greatest contrasts alongside each other; an estate where rigorous clean weeding was practised, with, as a necessary evil, a deep cultivation many times repeated, and next door to it an estate completely covered with a thick mulch, mostly of a species of *Pennisetum*, *P. giganteum* or *P. purpureum*, the so-called elephant grass, which is often specially cultivated as a source of mulch.

I saw mulching also in the native plantations. By comparison with similar mulches the specially favourable effect of banana leaves and rubbish had generally brought them to the

fore as a mulch. This has conveniently been made use of in Kivu, where the natives have, under more or less gentle compulsion, planted arabica. Everywhere in Central Africa bananas are grown as a very important food supply. They are mashed up in pots, ferment quickly and then provide a strongly alcoholic brew. The native knows that the banana greatly appreciates good soil and organic manuring and takes care that his banana garden shall get them so far as it may be possible. In Kivu the natives are now allowed to plant Arabica between the bananas, that is, in alternate rows. The expectation is that specially good spots will be chosen and that the coffee will benefit from the manure that is given to the bananas. Moreover it involves little trouble to spread the leaf-fall of the bananas between the coffee trees. However, that does not always work. I saw also coffee plantations between bananas where the coffee did not get enough of this incidental feeding, as the coffee plainly showed.

As I say, I came across a good deal of mulching with the aid of *Pennisetum*, which can grow to a height of over twelve feet. In Kenya and Uganda, as well as in the Belgian Congo, use is made of this grass for coffee and for other crops besides. The results I saw on estates round Mulungu were very striking. After a few months of mulching an obvious difference could already be seen compared with the adjacent untreated rows. I never encountered mulching with a permanent weed cover that was regularly cut, like the *Salvia* in Java. It was pointed out that it was too much trouble to get a great quantity of mulch and that the measures were not economic, since a start cannot be made with a big quantity all at once, which exactly agrees with our own experiments with mulching at Malang. It is certainly worth recommending that in Java, alongside the mulching that is practised on the estates at present, tests should be made with mulches of material derived from the big grasses, such as *Pennisetum*, and also from banana. On any estate areas may well occur that are of comparatively little use for crops, but they could be planted with some such source of mulch. One might even admit, as I have seen in Africa, a row of *Pennisetum* here and there into one's plantation, where the plant could also serve as a windbreak.

Another cultural operation I found much practised was the pruning of coffee, especially Arabica. I will not deal here with all the systems I saw applied, but rather indicate that pruning was practised to ensure that the trees reach and retain the desired form and that young and healthy bearing wood may always be available.

A pruning system has been sought that can be followed by the natives in their own plantations. This appears extremely difficult, as was to be expected. Exactly the same conclusion has been reached independently in the Belgian and the British districts, namely, that a system of three or more leading shoots is the most practical for the native grower[1].

I shall not discuss this system now, I will only say that it was found in Uganda that by no means all Robusta trees lent themselves to this system and that particularly bad results were obtained with planting material received from Java. Generally the stems grew too stiffly upwards and thereafter would not bend out, in contrast with the local material, which formed more pliable stems and bent better, so that new suckers for the formation of a new stem could come into existence. In the same way difficulties were met with in Java in working the multi-stem system and are appearing now in the working of branch grafts[2]. I saw at Kampala what striking trees can be obtained by this system, one in a native compound having a diameter of sixteen feet.

Moreover in the application of the multiple-stem system to Arabica culture selection plays an important part. At the Nairobi experiment station I learned that for the multiple-stem system special forms of Arabica with somewhat more rapid growth were needed, such as Blue Mountain, Guatamala and Padang, while Bourbon, with much stouter growth and more solid wood, was mostly kept on the single-stem system[3]. This selection of principle with regard to multiple-stemming appears therefore to be the opposite in Robusta to what it is in Arabica. The main point is, however, that production from primaries is furthered.

(*To be continued*)

[1] A system whereby the leading shoots are progressively bent outwards from the centre of the tree, resulting in very wide-spreading bushes has been devised by the native in parts of Bukoba and Uganda, and is very satisfactory.—L.R.D.

[2] In this connexion see articles on "The Branchgraft Problem" in *Archief v. d. Koffiecultuur*, 13 (2), 1939.

[3] In both cases a vigorous growth of pliable wood abundantly furnished with primaries is required. The level of fertility of the plantation and presence or absence of shade also have an important bearing on the applicability of this scheme of pruning.—L.R.D.

TOMATO JUICE

By the Staff of the Scott Agricultural Laboratories

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During the past few years there has been an increasing demand for such beverages as fruit squashes and straight fruit juices, one of the favourites being tomato juice. Most of these have been imported, but with the progress of the war the import will decrease and East Africa will have to be dependent largely on its own resources. Good fruit squashes are now being manufactured locally, but attempts to produce tomato juice on a large scale have not been successful. Actually, tomato juice is easy to make but difficult to preserve. It is a very pleasant drink and has a great food value, especially on account of its vitamin and potential vitamin content. Tomatoes grow very well indeed in Kenya, and it would be easy for the housewife to make tomato juice herself, while there should be no difficulty on the factory scale, always providing that the difficulty of preservation can be overcome.

As a result of a number of inquiries on the subject, experiments were started at the Scott Agricultural Laboratories to find out where the difficulties of preservation lay. Unfortunately, owing to shortage of fruit, it has not been possible to complete the experiments, but sufficient data are available to permit of the publication of a preliminary report which will enable most of the difficulties of preservation to be overcome. Some of the lots of juice that have been prepared in the laboratories have kept perfectly for a period of over two months; our first attempts went bad within a week.

The main difficulty in the preservation of tomato juice in bottles lies in the fact that corks contain in their pores enormous quantities of the spores of moulds and other fungi. Unless the corks are thoroughly sterilized before use the juice will go bad. At one time it was possible to obtain corks that were very free from holes and other defects, but to-day this is very difficult, and usually on putting a soaked cork into a bottle a milky juice is squeezed out of it. This juice teems with microbes.

The method that is usually employed to sterilize the corks is soaking them for twelve hours in a 2 per cent solution of sulphur dioxide, taking care that the thin end which goes into the bottle is not touched by the fingers; even then, if the cork is full of pores, it is still possible for microbes to be introduced.

It has been stated that coating the corks with a thin film of medicinal paraffin completely prevents the entry of spores. Although this method has not been tested in the experiments, it will be very well worth trying, at least on a household scale. If, when working on factory scale, crown stoppers are used, they too should be sterilized, either with sulphur dioxide solution or formalin. Better still would be the use of discs of tinfoil, sterilized by dipping in sulphur dioxide solution or by heating to 120° C. for half an hour.

Tomato juice as purchased is not the true juice, which is a clear yellow liquid with rather a mawkish flavour, but is really tomato pulp. The attractive red colour lies in the solid cells of the fruit. On standing the so-called tomato juice for any length of time it separates into two layers, the bottom a red liquid, the top the clear yellow juice. This is normal and not due to any defect in the juice. One usually buys tomato juice in cans which, no matter how careful one may be, are shaken before opening, so the separation into two layers is not noticed; a slight shake mixes the two together.

At first tomato juice was made by pulping the raw fruit, but the drastic treatment which is needed to break up the fruit reduces the vitamin content and also spoils the flavour. To-day fruit is always heated before extraction, which makes it easy to break up and at the same time makes the juice less liable to absorb air.

The great thing in making tomato juice is to take sound, dead-ripe fruit. Over-ripe tomatoes give the juice rather a flat flavour; under-ripe a juice of poor colour and flavour.

Preparation on household scale

Sound, fully ripe tomatoes are carefully washed to remove dirt. They are then scalded, either by pouring boiling water over them or by putting them into an oven until the skin bursts. While still hot they must be mashed thoroughly. A potato squeezer is most suitable for the purpose, but do not put in more than one or two tomatoes at a time, otherwise juice and pulp will squirt all over the place, and it will be difficult to break down the solid part properly. When the skins accumulate and begin to become a nuisance, scrape them out. It is advantageous to do this over a deep basin. Pass the mixture of juice and pips through a sieve; a flour sifter is very useful, failing which rub the pulp through the sieve with the back of a spoon, so as to break down small lumps of pulp, and throw away the pips. The juice is

improved by the addition of a little salt—a teaspoonful to a full quart. Stir the salt in really well, as it tends to form a lump in tomato juice; it could be dissolved in a little of the juice and then mixed with the whole.

In the meanwhile choose a sufficient number of good sound corks, preferably with even, unbroken thinner ends, and soak them in a 2 per cent sulphur dioxide solution, the formula for which is given below. Also, put the requisite number of bottles into a *debe* of water and heat almost to boiling. The juice is then put into a double cooker or into a pot suspended in boiling water. Stir until it is heated evenly throughout. Run the juice into the hot bottles; cork immediately with the treated corks. Put at once into the *debe* of hot water and allow to cool.

Treated in this way, the juice will keep for about a fortnight, but if it is desired to keep the juice for any period of time it is advisable to sterilize more completely in the following manner:—

The day after preparation, bottles are put, still corked, back into a *debe* of water, which is then placed upon the stove and allowed to heat to nearly boiling and kept at this temperature for at least half an hour. Remove the *debe* and allow the contents to cool slowly. Repeat the procedure the next day. Treated in this manner, the juice will keep indefinitely if the corks are sound.

Preparation on factory scale

It appears that it would be advantageous to produce tomato juice on a large scale in Kenya. Although a method has been described for household use, many people will not have the facilities nor the opportunity for making their own. There is a very fair local demand, which could be increased, and most probably there would be a demand from adjoining territories. There is no reason why passion fruit juice factories and perhaps the citrus squash factories should not add the production of tomato juice to their present activities. Supplies of tomatoes could be very easily developed. Although we have no definite information regarding the best types of tomatoes in Kenya for the production of juice, it is highly probable that the varieties found at the Plant Breeding Station, Njoro, to be the most suitable for canning—Marglobe and Harkness—would also be the most suitable for juice production.

Great care must be taken to obtain only dead-ripe tomatoes. They should be washed first by soaking and then, if available, in a rotary washer. From the washer the fruit passes to the sorting table, where only the best tomatoes are passed. It is stated that some manufacturers of tomato juice permit of green portions being cut out. Experience at the Scott Agricultural Laboratories indicates that such fruit is responsible for a poor colour.

The sorted, washed fruit should then be packed in shallow wire trays. About three layers of tomatoes will be found sufficient; if a greater depth is used, the lower layers on steaming tend to break down into a pulp, and there may be heavy losses of pulp and juice. Steaming at the Scott Agricultural Laboratories was done in a loosely covered vessel into which live steam was introduced. Under these conditions it was found that at least five minutes' steaming was needed to heat the tomatoes right through and to loosen the skins. If steam under pressure could be used a very much shorter period of steaming would be needed. The correct time is a matter for experiment.

The tomatoes pass straight from the cooker to the extractor. Two types of extractors are commonly used in the United States of America. One type consists of a tapered screw revolving inside a cylinder perforated with holes 2/100ths of an inch in diameter. As the tomatoes are carried down by the screw a pressure is exerted and the broken-down fruit pulp is forced through the screen. The extractor must be set so as not to exert too great a pressure, which may remove juice from the skins or crush the pips, both of which give a harsh flavour and a thick coarse juice. The other consists of a cutter and a series of rollers. It is most likely that the first type resembles the extractor used for passion fruit juice.

If the juice from the extractor is free from seeds and large pieces of pulp it is fit for further processing; if not, it must be screened again. A little salt added at this stage—about $\frac{1}{2}$ lb. per 10 gallons is the usual quantity—improves the flavour. It is not possible to add the salt in mass, as it sinks to the bottom, but it should be dissolved in a part of the juice by stirring and heating, and then added to the lot. In continuous processing it would probably be best to add salted juice in the correct proportion to the main flow.

The juice now passes through the de-aerator; the higher the temperature, the more rapid and complete the de-aeration. From the de-aerator it goes direct to the flash pasteurizer, which is run at a temperature of 170° to 180° F. If cans are used, pasteurized juice is run directly into them, sealed, and processed at 210° to

215° F. If, however, as is more probable, bottles must be used, the processing is rather more difficult. Clean bottles and sound corks, or better still crown stoppers, are required. The bottles must be hygienically cleaned and heated before being filled with the juice from the flash pasteurizer. They are immediately sealed with corks that have been soaked in a 2 per cent sulphur dioxide solution. The workers inserting the corks should wear rubber gloves to prevent reinfection. Alternatively, seal with crown corks provided with tinfoil discs that have been sterilized as described earlier. The sealed bottles are processed at 180° F., and on the two succeeding days are re-processed. Great care must be taken that the bottles are held at a temperature of 180° F. long enough for the whole mass of juice to reach this temperature. With ordinary reputed quart bottles laid on their side, at least one hour will be needed. Treatment of the juice with sulphur dioxide for preservation, or the use of paraffined corks, is not recommended.

APPENDIX

Formula for making 2 per cent sulphur dioxide solution:—

Potassium metabisulphite ..	300 grs.	5½ oz.
Water	1 pint.	1 gall.
Concentrated hydrochloric acid	½ oz.	3¾ oz.

The solution must be used fairly fresh, but can be preserved in securely corked bottles stored in the dark.

The vessel used for soaking the corks should be of glass or earthenware, or a wooden vessel coated on the inside with bituminous paint. The weight needed to keep the corks down in the solution should be glass—a bottle loaded with sand would do, or an iron weight coated with bitumen.

REVIEW: THE IMPORTANCE OF THE VARIETY IN POTATO PRODUCTION*

This paper deals mainly with the cultivation of potatoes in Scotland, where the production of high-class seed potatoes is an industry of considerable importance, not only to Scotland but to most of the British Isles. The points raised would apply equally to Kenya if the serious production of seed potatoes for export were undertaken.

Although derived from a few early types, in no other crop do so many varieties exist or have been so extensively studied. In Scotland alone there are about 100 varieties. The qualities of these many types vary so much that they can be used for widely different purposes. The most important commercial features are maturity (i.e. first and second earlies, maincrop and late), yield, disease resistance, keeping and cooking quality, and certain shapes and colours which find favour in certain markets to the exclusion of others. It is, for instance, well-nigh impossible to establish a purple-skinned variety on a market which is accustomed to a white-skinned variety.

In order to retain the special characteristics of any one variety, the question of purity becomes of paramount importance, and impure stocks will always fetch a lower price and may even be unsaleable as seed. Impurities in stocks usually arise from the planting of one variety on land infested with ground keepers of another variety and from inadequate separation in the field, which leads to mixing at lifting time.

The first consideration in the production of pure seed is the purchase of certified stocks. These are the produce of crops inspected during growth, and are given a certificate of purity of 99.5 per cent. This scheme of inspection is also in operation in Northern Ireland and in Eire, from which countries first-class seed is also produced. Such seed should be planted in land free from ground keepers and must be rogued systematically. Roguing depends on the ability to recognize individual varieties, a faculty which can only be developed by instruction and experience. Roguing also involves the elimination of plants showing symptoms of virus diseases.

Varieties are not absolutely stable, and variations are apt to occur from time to time. Some variations, such as Red King Edward, are regarded as improvements, but others, such as "bolters" and "wildings", are degenerate. Bolters are taller in growth and later in maturity than the normal types, and are very apt to occur in stocks of early varieties. This is chiefly because they are not recognizable until full grown, and the practice of burning haulms of seed crops when seed production is at its maximum must lead to an increase of these abnormal types in the stocks, as they produce more seed-size tubers than do normal plants. It is suggested that growers should allow part of their stock of earlies to reach maturity each year in order to facilitate the elimination of these types.

*T. P. McIntosh, *Gard. Chron.*, Vol. 107, pp. 116 and 132, March, 1940.

Wildings are plants with numerous stems, simplified leaves and small tubers; they multiply readily in stocks, and seriously affect the yield. They can be detected at any stage of growth and can therefore be easily eliminated. True stock seed will certainly be free from these variations. Bolters and wildings are not due to any pathogenic organism or virus, and are not capable of infecting neighbouring plants.

Not only do varieties differ in commercial qualities but also in their cultivation requirements. All varieties cannot be treated alike, although there are some adaptable varieties, such as Up to Date, Kerr's Pink, Arran Chief, and Great Scott, which require no special consideration. Others have certain peculiarities, such as habit of growth, susceptibility to disease, productivity and soil requirements, on which depend the necessity of sprouting, possibility of cutting sets, width and spacing of drill, and special treatment at lifting and storing. It is pointed out that not sufficient attention is given to the lay-out of varieties in the field with a view to reducing the spread of disease, an important consideration when the intensive cultivation of potatoes is contemplated. Certain diseases, for instance, dry rot, skin spot and scab, attack the tuber while in the soil, and land may become thoroughly contaminated with these organisms. It is clear that these diseases can be controlled to a certain extent by avoiding the planting of susceptible varieties on such land. The control of wart diseases by the introduction of immune varieties is, indeed, a classical example of the importance of variety in disease control.

With regard to virus diseases, a different situation arises as infected plants and insect vectors have to be considered and not the soil. Even this problem is capable of partial solution on a varietal basis. For instance, although there are no varieties immune from Leaf Roll, certain varieties such as Arran Consul, Golden Wonder and British Queen are more severely affected than others. These varieties should be avoided in the neighbourhood of towns and allotments where aphids are likely to abound.

The Y virus (Leaf Drop Streak) is not prevalent in Scotland, and is therefore not considered, but stocks are frequently affected with viruses A and X. As seed producers are generally obliged to grow several varieties a knowledge of the reactions of these varieties to the viruses makes it possible to plant them in such a way as to reduce the likelihood of infection spreading. The principles followed are: (*a*) carriers of the same virus may be planted together; (*b*) carriers of different viruses may not be planted together; (*c*) susceptible varieties should not be planted next to carriers or together unless they are free from A and X; (*d*) varieties field-immune from A and X are excellent for separating all types, as blocks of immune stocks not only separate susceptible varieties but also form traps for the aphids, and in this respect are considered better than turnips or other crops.

The production of new varieties still continues, and has been concerned mainly with immunity from wart disease, cooking quality and tuber shape. There has been little improvement in yield since the introduction of Up to Date and British Queen in 1892. The success which has attended the breeding of wart-immune potatoes is shown by the acreage of immune and non-immune planted in Scotland. These in 1918 were 27,461 and 104,514 respectively, and in 1938 86,467 and 32,478. The author considers that there are still possibilities of further development of improved types, especially as regards yield, cooking quality, resistance to virus diseases and common scab, but these are limited. Further advance can only be made by introducing qualities found in other species. The recent introduction by Russian scientists of species from Central and South America has provided much new material. The two main qualities these species are likely to impart are resistance to blight and frost. A number of Mexican species are immune from blight; other species from high altitudes in the Andes can withstand temperatures of $-5°$ C. It is further possible to combine frost tolerance with a short growing period, a matter of importance to growers of first earlies. Other species again appear to be immune from corky scab, black leg, and show resistance to certain virus diseases and even to Colorado beetle. Some species may also be valuable in the production of varieties suited to warm climates. There is no indication that these hybrids will succumb to the more virulent bio-types of *Phytophthora infestans*, and Blight resistance is a dominant character not linked with any undesirable commercial features. In the words of the author, "the promised land is not far distant."

R.M.N.

THE BOMBAY POTATO MARKET

By V. Liversage, B.Sc. (Lond.), M.S. (Wis.), N.D.A., Agricultural Economist, Kenya

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The bulk of the potatoes imported into Bombay come from Italy. Japan made an attempt to enter the market recently, but the potatoes received from that country, though externally appearing to be of the kind desired, proved to be slimy on cooking and have proved unacceptable. The following figures indicate the proportionate share of Kenya and Italy in the market:—

	Kenya. Cwt.	*Italy.* Cwt.	*Other Countries.* Cwt.	*Total.* Cwt.
1935-36 ..	39,134	70,634	33,742	143,510
1936-37 ..	44,408	82,594	10,008	137,010
1937-38 ..	22,792	192,903	3,446	219,141
1938-39 .. (incomplete)	78,270	157,404	—	—

The main market falls into two divisions:—

(*a*) Table potatoes imported during the monsoon period—July to September—when the local supply is short. For this trade large potatoes are suitable. The type desired is a round white-fleshed potato which is firm after cooking (not floury, like a good English table potato). It appears that the quality required is somewhat similar to that required for the "chipping" trade in England. Italian potatoes have very deep eyes, but this is not considered objectionable.

(*b*) Seed potatoes from October until the end of the year. Potatoes in India suffer from a variety of diseases, and after two or three years fresh clean stock is necessary. This fresh stock is now obtained chiefly from Italy. Naturally the seed must be of the type required for the table market, but small sizes are preferable. The Italian potatoes are practically ready-sprouted when they reach Bombay. The potatoes should have as many eyes as possible, as the economical Indian cultivator cuts his seed to the limit, and in this respect the Italian potatoes have an advantage over the other types so far imported.

Imports during the 1938 season were as follows:—

	From Kenya— Cwt.	Rs.	*From Italy*— Cwt.	Rs.
April ..	—	—	—	—
May ..	87	550	—	—
June ..	2,843	15,116	—	—
July ..	5,012	27,295	9,425	55,244
August ..	7,244	40,160	14,822	91,040
September ..	8,621	53,482	18,958	103,650
October ..	22,594	127,081	39,268	308,426
November ..	26,634	147,114	49,966	377,007
December ..	5,235	26,881	4,965	37,906

After December, local potatoes come on the market in quantity and importation ceases.

Kenya potatoes are usually consigned to Bombay merchants operating on a commission basis. According to established custom, the commission is reckoned at so much per package, and not as a percentage of the price obtained. The East African shipper may be informed as to the ruling price before shipment but has to take his chance when the potatoes actually arrive. His position thus appears to be a weak one. It is further weakened by the fact that East African potatoes will keep for only a short time after arrival, while Italian potatoes will keep for a month or so. A large shipment would depress prices very considerably, and it was stated that 2,000 bags is the most that should be sent in one shipment.

Italian potatoes, on the other hand, are consigned to an agent in Bombay, who sells them to the wholesale merchants.

The following were quoted as representative wholesale prices in Bombay market for seed potatoes during the seed season:—

Italian: Rs. 1/10 per maund = Rs. 130 (say, Sh. 195) per ton.

African: Rs. 1 per maund = Rs. 80 (say, Sh. 120) per ton.

Conclusion

An attempt to capture a greater share of the Indian trade would involve the following:—

(*a*) A better method of sale.

(*b*) Improvement of keeping quality.

(*c*) An improved type of potato.

(*a*) It would appear preferable to try to do business through a local agent operating on a percentage commission basis, with, if possible, limitation of quantities in single shipments.

(*b*) Investigation into the causes of poor keeping quality in Kenya potatoes is needed. This may be connected with unavoidable circumstances, such as the climatic conditions under which the potatoes are grown and temperatures during shipment. The stage of ripeness and the type of package used may also have some influence. Baskets are used for the Italian potatoes. The writer was shown a type of sack now being imported from Penang, with a mesh of one-eighth or one-quarter inch, which is said to be good. It holds about 1 cwt. It seems possible that this might be imitated in sisal in Kenya.

(*Continued on page* 42)

NOTES ON ANIMAL DISEASES

Compiled by the Department of Veterinary Services, Kenya

VII—NAIROBI SHEEP DISEASE AND HEARTWATER

(*Received for publication* 31*st May*, 1940)

Although the causal agents of these diseases are not closely related it is convenient to describe them together in these Notes. Both are tick-transmitted, and, in sheep, confusion between them is not uncommon.

Nairobi sheep disease

Nairobi sheep disease is a tick-transmitted disease of sheep and goats, characterized by gastro-enteritis and caused by a true filtrable virus. So far as is known it occurs only in East Africa.

Etiology and transmission.—The virus of Nairobi sheep disease is one of the smallest of the filtrable viruses. It is a resistant virus, and may be stored for several months at a temperature of +4° C. in the dry state or mixed with citrate solution or O.C.G. preservative. Viability is retained for several days at atmospheric temperatures.

The disease is not contagious, and, in nature, transmission is effected by ticks. The most important vector is the brown tick, *Rhipicephalus appendiculatus*, the common vector of east coast fever. It will be recalled that this is a three-host tick. Larvæ that feed on an infected sheep during the temperature reaction are, after dropping and moulting, capable of infecting susceptible sheep as nymphæ. Similarly, ticks infected as nymphæ are infective as adults. Adult female ticks that feed on infective blood produce eggs from which larvæ capable of transmitting infection hatch. The disease is therefore carried over between any two adjacent stages. Infection has been found to persist in unfed ticks until death occurs. In nature therefore the tick acts as a complete reservoir of the disease.

Infected ticks that feed on an immune animal lose their infection and at the next stage are clean. It is also known that when infected ticks feed on a susceptible animal and infect it, they will retain their infectivity in the succeeding stage only if they remain attached until the temperature rises and virus appears in the blood. In other words, for the virus to be carried over, the ticks have to be reinfected.

The bont-tick, *Amblyomma variegatum*, is also capable of transmitting infection; but is not as efficient a vector as the brown tick. In this species transmission through the egg has not been demonstrated.

Of the other species tested, transmission has been effected on one occasion with two adult female *R. bursa* that were collected as engorged nymphæ on a natural case of the disease. Several attempts to confirm this transmission have not been successful, and numerous efforts to obtain transmission with *R. simus*, *R. evertsi*, *R. pulchellus* and *Hyalomma ægyptium* have all failed.

Species susceptible.—The disease affects sheep and goats, and cannot be transmitted to cattle. The susceptibility of antelope has not been tested, but certain field rats have been infected experimentally. In Kenya, the native breeds of sheep, if obtained from areas where the disease does not occur, are highly susceptible. The disease is usually acute and mortality approaches 100 per cent. Goats and cross-bred Merino sheep are much less susceptible. Lambs are somewhat less susceptible than adults, and in enzootic areas the majority of adult native stock are immune.

Symptoms.—On exposure to infection from ticks a sharp rise of temperature occurs in five to six days, whilst following the inoculation of blood the incubation period is shorter, about 36 to 72 hours. The temperature may remain elevated for five to nine days, but in hyperacute cases it falls suddenly after two to four days. With this rapid fall in temperature other symptoms may develop and the attack usually ends fatally. In less acute cases the temperature falls more slowly, other symptoms develop and death may occur. In a number of cases, however, after the temperature has been more or less normal for three to seven days, a second reaction is seen. This second reaction may terminate fatally, but more commonly recovery ensues without the appearance of noticeable symptoms.

Noticeable symptoms, which are often lacking, consist of a muco-purulent nasal discharge, light to dark green diarrhoea, and rapid and apparently painful breathing. In the later stages the appetite is lost and the animal is unwilling to rise. The external genitals of ewes are often swollen and inflamed.

During outbreaks in cross-bred Merino ewes abortion is a frequent sequel. The actual attacks of the disease often pass unnoticed, but abortions and deaths, due mainly to sepsis following abortion, occur.

Post-mortem lesions.—Lesions are found in typical cases in the fourth stomach, intestines, kidneys, spleen and heart.

The mucous membrane of the fourth stomach may be diffusely congested over its whole surface or fine, pin-point hæmorrhages may be scattered over the folds on the anterior portion only. Catarrh and hæmorrhages may be found in the early parts of the small intestine but are more frequently restricted to the section joining the large gut. The ileo-cæcal valve is swollen and sometimes congested. The most severe lesions are usually encountered in the cæcum and the earlier parts of the colon. These lesions consist of longitudinal bands of congestion or even hæmorrhage, and in severe cases they may extend throughout the large gut to the anus. The contents of the large gut are fluid and often show flecks of blood.

The liver is unchanged, but the gall bladder is often distended with thick, sometimes grumous, yellow or deep brown bile.

The spleen is enlarged, often greatly so. The Malpighian bodies project from the cut surface and the pulp is usually dark in colour.

The medulla of the kidneys is usually very dark and congested. Lines of congestion extend through the boundary layer for some distance into the cortex and the cut surface of the cortex is granular and somewhat congested.

Hæmorrhages are usually present on the outside of the heart, and almost constantly in the left ventricle.

Diagnosis.—Whilst in sheep of native breeds a diagnosis can usually be made from the lesions present on post-mortem examination, difficulty is often experienced in the case of cross-bred Merino sheep. When in doubt, a sample of blood should be collected in citrate solution or O.C.G. preservative and forwarded to the Veterinary Laboratory, Kabete. At the Laboratory the sample is tested by the inoculation of sheep, so a reply cannot be given in less than seven to ten days.

Alternatively, a sick sheep may be sent for examination.

Treatment.—No satisfactory vaccine has yet been developed, nor has any medicinal treatment been proved of value.

In the case of outbreaks the measures of control to be adopted are segregation of the sick sheep, removal of the healthy sheep to clean ground, and a vigorous effort to reduce the tick population. Methods of tick control are described in the following section on heartwater.

Heartwater

Heartwater is a tick-transmitted disease caused by *Rickettsia ruminantium*.

Etiology and transmission.—A *Rickettsia* is a minute intracellular parasite, that of heartwater being found in the thin layer of cells lining the bloodvessel walls. Although *Rickettsiae* cannot be demonstrated in blood smears, during the temperature reaction and for a period afterwards the blood is infective. Before the discovery of the causal organisms, it was customary to speak of the "virus" of heartwater being present in the blood at this time.

Heartwater blood, however, loses its infectivity within a very short time of collection, and the "virus" has little in common with the true filtrable viruses such as that of Nairobi sheep disease.

All the *Rickettsia* diseases—typhus fever and tick typhus are other examples—are transmitted under natural conditions by such arthropods as lice, fleas and ticks. *Rickettsia ruminantium* is transmitted by ticks of the genus *Amblyomma* The usual species involved in Kenya is *A. variegatum*, whereas in South Africa *A. hebraeum* is the principal vector.

Heartwater is carried from the larval to the nymphal and from the nymphal to the adult stages in the tick; but infection is not conveyed through the egg from the adult to the larva. Contrary to what happens in east coast fever and Nairobi sheep disease, ticks infected as larvæ, if fed on an immune animal as nymphæ, do not lose their infection and are still capable of transmitting the disease after moulting to adults.

Species susceptible.—Heartwater is a disease of ruminants. Sheep, cattle and goats are all susceptible. Probably the native African breeds are somewhat more resistant than imported and cross-bred stock, and a high percentage of immune adult animals are to be found in areas where the disease is enzootic. In general, cattle are less susceptible than sheep. Experiments in South Africa have shown that at least two species of antelope may be infected, although the disease in antelope is

not characterized by the development of clinical symptoms; "virus" appears in the blood, which becomes infective for ticks. Moreover, infected nymphæ fed on buck do not lose their infection. Game therefore are capable of maintaining infection in an area kept free from domesticated ruminants.

Symptoms.—In experimental cases following the inoculation of blood the first sign of infection in sheep is a rise of temperature, which occurs usually after a lapse of seven to fourteen days. Following the attachment of infected ticks the temperature rises in eleven to eighteen days. In cattle the incubation period is somewhat longer, being thirteen to seventeen days in cases induced by the inoculation of virulent blood.

Four forms of heartwater are recognized in sheep—peracute, acute, subacute and heartwater fever. Peracute cases are rarely recognized outside the laboratory. Death occurs suddenly within a few hours of the first rise in temperature, and except for uneasiness and heavy breathing shortly before death, no symptoms are shown. In acute cases death is delayed for one or two days after the first temperature rise. The sheep frequently stands "propped up" on its four legs, unwilling to move and breathing heavily. If pushed it may have difficulty in keeping its balance. In subacute cases, death is still further delayed and the sheep may even recover. Diarrhoea is sometimes present, and nervous symptoms, for example, continuous champing of the jaws, twitching of the muscles, walking in circles and paddling of the legs while lying on the side may be observed. Nervous symptoms may often be brought on by handling the sheep or by driving it in an effort to catch it for examination. The appetite in subacute cases may be maintained until shortly before death, although death is not infrequently preceded by a period of apparent coma. Animals in this state, if picked up, will often commence to feed and will continue normal for a short while. In heartwater fever, the only symptom is a rise in temperature, which lasts several days.

In cattle, the disease is almost always of the subacute or of the heartwater fever type. Clinical symptoms, if present, resemble those shown by sheep affected with the subacute form, with prominent manifestations of brain disturbance.

Post-mortem lesions.—The post-mortem appearances of peracute and acute cases are very similar. In subacute cases, when the animal has been ill for several days, lesions are usually indefinite or lacking.

The carcass is usually in good condition. If the animal has had convulsions or has been down for some time, there may be abrasions of the skin and frequently blood-stained froth is exuding from the nostrils.

The thorax contains from half an ounce to a quart of straw-coloured or, sometimes, blood-stained fluid, in which clots of fibrin may be present. The occurrence of a similar exudate in the pericardial sac is responsible for the name "heartwater". The heart may show pin-point hæmorrhages on the outside and extravasations of blood beneath the lining of the ventricles, especially on the left side.

The œdema usually found in the lungs in sheep forms a very characteristic lesion. The lungs do not collapse and the surface appears veined as a result of the presence of fluid in the interlobular tissues. The lower borders of the lungs are frequently the more heavily infiltrated, and if after removal from the chest the lungs are left on a hard, flat surface, a considerable quantity of straw-coloured fluid will soon exude and collect around the lower edges. Emphysema may be present, and occasionally there is some hypostatic congestion or pneumonia.

The peritoneal cavity often contains a small excess of fluid. The liver is swollen and congested, and the spleen also is usually enlarged. The kidneys appear congested, especially in the boundary zone between the medulla and cortex, and hæmorrhages may be present in the latter. In the alimentary tract, scattered hæmorrhages occur on the folds of the fourth stomach and there is often marked congestion of the pyloric region. On opening the cæcum the fine vessels of the lining membrane frequently appear injected and sometimes there are lines of hæmorrhages along the thickened wall of the rectum.

The brain is very moist in appearance, and dilatation with blood renders the vessels, which form a network on its surface, abnormally prominent.

The thoracic lesions are less constantly found in cattle that die of the disease, and it is not an uncommon experience for several cattle to die in the early stages of an outbreak without typical lesions in the thorax. Frequently the only lesion in cattle, apart from the general manifestation of a septicæmia, is a noticeable congestion of the brain and its membranes.

Diagnosis.—The causal agent in the circulating blood cannot be seen in smears, and, owing to the short period for which blood remains infective after collection, blood cannot be sent to the Laboratory for diagnosis by the inoculation of animals.

In order to confirm the presence of heartwater, a portion of the brain should be removed and despatched to the laboratory in formalin solution. In the majority of hyperacute and acute cases of the disease in sheep it is possible to demonstrate the presence of *Rickettsia* in the small blood vessels of the brain, and even when the micro-organisms cannot be found, changes produced by the disease can usually be detected. In cattle, *Rickettsia* cannot be so frequently demonstrated, but a provisional diagnosis can usually be given from the lesions. *Rickettsia* can also be found in other tissues (for example, kidney and spleen), but the search for them is more arduous, and whereas when examining brain the lesions form a valuable clue to the diagnosis, lesions in the spleen or kidney are not characteristic. In practice therefore the submission of brain is much to be preferred.

Rickettsia can frequently be found in smears made from scrapings from the lining of the jugular vein. The preparation of such smears requires considerable skill, however, and at Kabete this method has not proved as reliable as the examination of sections of brain.

Treatment.—Medicinal treatment has so far proved of little, if any, value. Affected animals should be isolated and kept in a cool place, sheltered from sun and rain.

Under experimental conditions, intravenous injections of "Uleron" have apparently given good results in sheep in South Africa. This preparation is made by the German firm of Bayer, and is therefore unobtainable at the present time. Under farm conditions, moreover, it is only occasionally that cases could be detected sufficiently early for the treatment to prove effective.

Control.—As no method of immunization against heartwater has, as yet, been devised, the disease must be controlled by hygienic measures and by attacking the tick vector. Sick animals should be isolated and the healthy ones moved to clean grazing.

In order to control the ticks, cattle should be dipped in a seven-day strength dip, and such parts of the body as are not penetrated by the dipping solutions, the eyes, ears, prepuce of male animals, the brush and underside of the tail, should be hand dressed.

Native sheep can be dipped once a week in a seven-day strength cattle dip. Woolled sheep, which are not usually put through a cattle dip, may be hand dressed with a mixture of one part of 7 per cent nicotine tobacco extract to eight parts of oil (for example, old engine oil). This mixture should be kept well stirred while being used or cases of poisoning may occur. Woolled sheep may also be walked once a week through a shallow bath containing seven-day strength cattle dip to a depth of about one foot. This treatment, combined with hand dressing of the axillæ, the udder, inside the thighs and under the tail, is probably the most satisfactory method of controlling tick-borne disease in woolled sheep.

THE BOMBAY POTATO MARKET

(*Continued from page* 38)

(*c*) The whole outlook would be changed if the price obtained were similar to that of Italian potatoes. The Kerr's Pink now being shipped from Kenya are suitable only for European consumption and for seed in certain hill districts such as Mahableshwar. For the main market they are too breakable on cooking.

Under the direction of the Imperial Research Council attempts are being made to secure seed by growing potatoes in hill districts such as Simla, multiplying stocks at intermediate altitudes, and thus providing a flow of seed for the main crop on the plains. This may take some time, however, and there would still be the handicap of a long rail haul to Bombay district.

The first step must be to try to find the right type of potato for the market and for our conditions. This can only be done by actual trial. The Italian potatoes are said to be very free from disease. A variety which seems worth trying is King Edward, which would have the requisite firmness after cooking. Other likely types should be sought, in an effort to combine suitability for the Indian market with high yield and suitability from the native growers' point of view. It does not follow that a variety which is suitable when grown in Italy or England will exhibit quite the same characteristics when grown in Kenya, and the characteristics will only become fully apparent after cooking. Hence expert examination of trial consignments is an indispensable part of the necessary investigation.

THE LOCUST TRACHEAL MITE

By W. Victor Harris, Entomologist, Department of Agriculture, Tanganyika Territory

(*Received for publication April*, 1940)

Mites are found living on many insects. Some appear to show little preference for a particular part of their host and are to be discovered in dozens clinging to any part of the unfortunate insect that offers a foothold. Others are more specialized, and attach themselves to one part only, as is the case with one mite that lives on the antennæ of a particular ant. Dung beetles frequently support a large population of white or yellow mites on the under-surface of their bodies; grasshoppers are often found with bright red mites on their wings; while the caterpillars of the smallest moths have their own particular small mite.

Some mites belonging to the family Tarsonemidae have developed a step further, and penetrated inside their host. So far three such mites have been found. The first to be discovered was *Acarapis woodi*, the cause of Isle-of-Wight disease in honey bees. This mite lives in the tracheæ or air tubes of the bees, and by increasing in numbers and blocking up the tubes causes the host to die of suffocation. Then in 1914 a mite was found living in the tracheæ of two American grasshoppers, *Hippiscus apiculatus* and *Arphia carinata*, which was described by Ewing (1924) as *Locustacarus trachealis*. The third species was discovered by the writer in the tropical migratory locust, *Locusta migratoria migratorioides*, and described by Ewing (1932) under the name of *Locustacarus locustae*.

The genus *Locustacarus* Ewing differs from other members of its family by having only three pairs of legs instead of the normal four pairs.

The following is Ewing's original description:—

Locustacarus locustae. Non-gravid Female. (Fig. 1).—Body stout, almost spherical. Capitulum about as long as broad, with several minute terminal or subterminal setae and a pair of long conspicuous dorsal setae. Chelicerae needlelike, somewhat looped at the base, and in repose not quite reaching the tips of the first pair of legs. Cephalothorax covered above by a poorly sclerotized plate and bearing three pairs of dorso-lateral setae, the first pair being the shortest and the last pair the longest; the second pair is about equal to the cephalothorax in length. Abdomen short, reduced, with a large dorsal plate in front which is separated by a transversely lined cuticle from a small, disc-like, dorsal plate at the rear. Anterior dorsal plate of abdomen with a very large, conspicuous pair of setae at the posterior angles and a minute discal pair. Posterior dorsal plate of the abdomen ending in a conspicuous tubercle that bears a pair of very long, sub-median setae, equal in length to about one-half the width of the abdomen. In addition the posterior dorsal plate bears a pair of small setae near its anterior margin. Anterior pair of legs broad to their tips; tarsi each with a sessile pulvillus and degenerate claws and with sensory seta lateral and very close to posterior margin. Second pair of legs tapering; tarsi each somewhat bifurcate distally with two clawlike processes, the inner being the stouter, and a large pedicellate terminal sucker. Posterior pair of legs similar to the second pair, except that the tarsi lack the claw-like processes.

Length of non-gravid female, 0.19 mm.; width, 0.14 mm.

Type Host.—A grasshopper, *Locusta migratorioides.*

Type Locality.—Shinyanga, Tanganyika Territory, Africa.

Type Slide.—U.S.N.M. No. 1049.

An abundance of material at hand consisting of eggs, newly hatched females, and females in various stages of engorgement. No males found. This species differs from *L. trachealis* Ewing in being stouter, having very definitely sclerotized dorsal plates, smaller claws, better developed pulvilli or suckers on the second and third legs, and in a number of less important details.

The locust tracheal mite was first found, as indicated, in the tracheæ of migratory locusts at Shinyanga, Lake Province, during the initial infestation of Tanganyika by this particular locust in 1932. It was found again the following year at Morogoro in the same kind of locust, and has recently been referred to in reports from Kenya. In the interim it has not been found by the writer in our indigenous grasshoppers.

Insects do not have lungs, but bring the oxygen of the air into contact with their equivalent of blood by means of a system of branching tubes (tracheæ), which open out in a series of holes (spiracles) on either side of certain of the segments of the thorax and abdomen. Locusts have ten pairs, situated on the second and third thoracic segments and the first eight abdominal segments. In locusts, as in

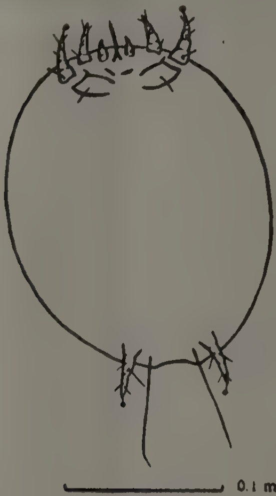

Fig. 1—*Locustacarus locustae*; non-gravid female.

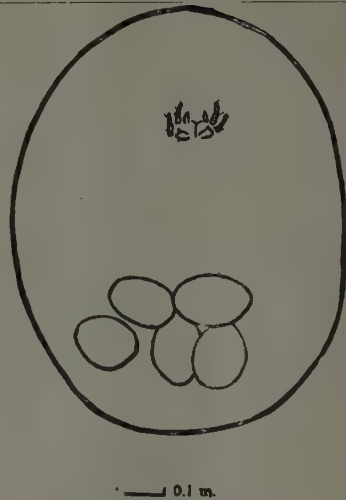

Fig. 2—*Locustacarus locustae*; gravid female.

many other insects of strong flight capacity, the spiracles of the thorax are large and the tracheæ leading from them are large also, in order to supply plenty of oxygen to the flight muscles. The thoracic tracheæ also lead into a pair of large air sacs, themselves in reality enlarged tracheæ, which are believed to be of some importance to the locust during migratory flights. It is in these larger tracheæ and air sacs of the thorax that the mites are usually most numerous.

The young mites are active and may be found on the outside of the locust, sheltering beneath the wing-joints or in the inter-segmental grooves. They penetrate the spiracles and settle down in the tubular tracheæ, where in course of time they swell as their eggs develop, making a distinct bulge if they have chosen one of the finer tracheæ. Others pass on into the air sacs, where there is ample room for development. From the eggs, the adult mite hatches out without passing through any larval stage. In the case of the American mite it was established that there are two extra embryonic stages to compensate for this. The younger mites are ovoid (0.19 mm. by 0.14 mm.), hyaline and shiny. When distended with eggs, the mite is almost spherical (Fig. 2) (0.75 mm. in diameter), and pale yellow in colour. They can be detected with a hand lens if the tracheæ and air sacs are dissected out in weak salt solution. No males of *L. locustae* have so far been found, and it is thus possible that reproduction is parthenogenetic. This would facilitate the multiplication of the mite where contacts between the hosts are infrequent and ensure the maintenance of an infection once begun.

In the case of Isle-of-Wight disease in bees, infection by mites quickly leads to symptoms of distress. Not only is difficulty in respiration caused by the blocking up of spiracles and tracheæ with mites, alive or dead, but injury results from the feeding punctures of the mites in the tracheal walls. Infested bees lose control of their flight muscles, the wings stick out at odd angles, the bees crawl about instead of walking in their usual purposeful manner; finally, the bees die.

The finding of a similar parasite in the migratory locust aroused hopes of a useful natural control, which did not materialize. All swarms at that time found to be heavily infested with mites were swarms which had already laid eggs in a manner indicating little impairment of their abilities in that direction at least. Further information about the mite in other parts of the migratory locust's range is required before it can be dismissed as useless. Conditions in other areas may facilitate the more rapid multiplication of the mite, and so affect the locust before it reaches maturity.

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RECENT PROGRESS IN THE CULTIVATION OF TUNG OIL TREES

By C. C. Webster, B.Sc., A.I.T.A., Department of Agriculture, Nyasaland

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Introduction

During the past fifteen years plantations of *Aleurites fordii* and *A. montana*, ranging from small experimental plots to large estates, have been made in almost all tropical and sub-tropical countries. From the numerous reports which have from time to time been published it would appear that the results so far obtained from these very extensive trials are rather disappointing. No country has yet been able to report the existence of a profitable commercial tung plantation; in many, probably the majority, of the territories results have not been promising or are still very inconclusive, and in many others the trials have been abandoned. In this article it is proposed briefly to summarize progress made in those countries where trials have reached the stage of giving results of interest and to discuss certain difficulties and problems which have arisen and which in part account for the slow rate of progress.

Progress in Territories where Tung has been Extensively Planted

The U.S.A.—In America planting has been confined to the species *A. fordii*, as the few trees of *A. montana* which were planted experimentally did not give results of sufficient promise to warrant more extensive trial. The first plantation of *A. fordii* was established at Gainesville, Florida, in 1912, but intensive development of tung planting did not commence until 1922, when further trials were instituted, followed by considerable commercial planting. The total acreage planted in the six states of Mississippi, Florida, Louisiana, Georgia, Alabama, and Texas was reported in 1937 to be between 42,000 and 45,000 acres [1]. This is, of course, a far greater development than has occurred anywhere else in the world and it includes a number of plantations considerably older than any to be found in other countries. In spite of this, however, very few reliable yield figures are available and those which have been published do not indicate that a flourishing industry has been established. It seems fairly certain that a great deal of unsuitable land was utilized for tung planting in the past and that considerable areas have had to be abandoned. A survey of the tung plantations in the six states mentioned above which was published in 1935 [2] showed that 562 acres of six-year-old trees gave an average yield of 278 lb. of fruit "as gathered" per acre. This fruit presumably contained a certain amount of moisture, but even if it is assumed that it was air-dried this figure is only equivalent to approximately 140 lb. of seed or 52 lb. of oil per acre. It was further stated that approximately 300 acres of trees seven to eleven years old gave an average yield of 343 lb. of fruit per acre, which, on the same basis, is equivalent to 172 lb. of seed or 64 lb. of oil per acre. These results certainly cannot be regarded as encouraging, as a yield of little more than half a cwt. of oil per acre from trees over seven years old would not be profitable on a cultivated plantation.

The Netherlands Indies.—Both species have been extensively tried since 1925, but no data regarding the area planted or the yields obtained is available. Results obtained with *A. fordii* have been poor, but *A. montana* is said to be very promising. The need for improved planting material has been fully realized, and work on selection and vegetative propagation has already been put in hand. The use of *A. fordii* budded on to a *montana* stock is also under trial.

Indo-China.—*A. fordii* is occasionally found growing wild in some districts in the north of the territory, but trial plantations have given poor results. *A. montana* is indigenous and common in forest regions throughout Indo-China, and has long been planted as a shade tree in coffee plantations and in the neighbourhood of villages. A considerable native industry has been in existence for some time, the fruit being collected from wild and shade trees and the oil extracted with simple presses and sold locally. For many years also planters have been establishing small plantations of this species, but these have never been successful because, although the trees grew well, the yields obtained were not sufficient to be remunerative. It was concluded that the cultivation of *A. montana* as a plantation crop would not be profitable unless improved planting material were available, and investigations with the object of producing such material are in progress at the experimental stations of Tuyen Quang and Phu Ho [1], [3], [4] and [11].

The U.S.S.R.—Considerable interest has been taken in tung planting for some years, but the published information available is very scanty and more attention has been devoted to *Aleurites cordata* than to the other species. Extensive trials with *A. fordii* have, however, been made in Trans-Caucasia and Georgia, and the total area under this species in 1937 was stated to be 5,704 hectares.

Australia.—A fairly large acreage has been planted with *A. fordii* in Queensland and New South Wales, but although the tree clearly flourishes in certain districts it has nowhere reached the stage of a proved commercial proposition. Reliable yield figures from a fair-sized plantation do not appear to be available, but isolated trees have given very promising yields and it has been reported that the majority of trees aged three to four years old produce on an average 300 fruits per annum. While the results so far obtained are far from conclusive, it appears that *A. fordii* is showing more promise in these territories than anywhere else in the Empire.

New Zealand.—Trials in New Zealand have been confined to *A. fordii* since the few experimental trees of *A. montana* and *A. cordata* which were planted did not do at all well. Burns *et al.* [5] report that approximately 5,500 acres of *A. fordii*, aged one to six years, were being maintained in 1937, but their survey of the groves revealed a very unsatisfactory state of affairs. Selection of land for tung planting had been very unwise, and at least 70 per cent of the trees had been planted on badly drained, infertile soil. Methods of planting had also been unsatisfactory, and it was further suggested that the summer temperatures experienced in North Auckland might not be sufficient to bring the fruit to maturity every year. Several plantations have apparently already been abandoned, and only one or two growers are continuing to extend their acreage. Another report [6] states that in 1938 there were in New Zealand 55 acres of apparently satisfactory trees, 733 acres of unsatisfactory trees, and 3,760 acres of dead or dying trees.

India and Burma.—Trials have been made with both species in the Dehra Dun District, in Assam, and in the Ranchi District of Chota Nagpur. No conclusive results have yet been attained, but the indications are that *A. montana* is more promising than *A. fordii*. In Burma the results obtained from experimental plantings in the more tropical districts have been unsatisfactory, but prospects are very much better at the higher elevations of the Shan States, where at least one large commercial plantation has been established. It is quite clear that *A. montana* is very much more promising than *A. fordii*. The former species grows in a semi-wild condition in small patches throughout the Shan States, probably having been introduced from China by Buddhist monks.

East Africa.—Trials with *A. fordii* have been made in Kenya by the Agricultural and Forestry Departments and by a number of European planters. The general conclusion has been drawn that this species is not promising, and that no further planting can be recommended. A few trials with *A. montana*, commenced more recently, show distinctly better promise. The position is somewhat similar in Tanganyika. In Uganda, both species have been planted on a small scale, but without encouraging results. [7].

More progress has been made in Nyasaland than in any other African Colony. Rather more than 2,000 acres had been planted on European-owned estates by the end of 1938, and this area has been considerably extended by further planting during the last rains. Both species are being grown, but there is probably rather more *montana* than *fordii*. Records of yields are not yet available to any extent as almost all the trees are less than five years old; it is therefore not possible to make any conclusive comparison of the two species. The writer is of the opinion, however. that *A. montana* is so far distinctly more promising than *A. fordii*. The yields of two of the oldest experimental plots are of interest, although they do not necessarily represent the full potentialities of young trees, as the *montana* plot is not situated in the most suitable area for tung and the *fordii* trees have received no cultivation except cutlassing of the grass once or twice a year.

TABLE I.—YIELDS OF EXPERIMENTAL TUNG TREES, NYASALAND

Lb. of Air-dried Seed per Tree

A. montana (128 trees) Agric. Dept., Zomba, 3,500 ft.—					
Age in years ..	3	4	5	6	7
Yield in lb. ..	1·75	3·6	6·64	9·46	11·02
A. fordii (62 trees) Forestry Dept., Zomba, approx. 4,500 ft.—					
Age in years ..	7	8	9	10	11
Yield in lb. ..	0·37	0·75	1·6	1·85	2·35

Some account of the cultivation of *A. montana* in Nyasaland has already been published [8].

Conclusions

From a consideration of the results reviewed above, two points emerge:—

(1) Tung oil has nowhere yet been successfully established as a profitable plantation crop.

(2) Although it is not possible to obtain yield figures in order to effect a comparison of the two species over a period of years, it appears that in all the tropical countries where both have been tried (Netherlands Indies, Indo-China, India, Burma, East African colonies), *A. montana* has been found to be the more promising. This fact in itself has delayed progress in the Empire since almost all the earlier trials were made with *A. fordii*, and it is only comparatively recently that the better results have been obtained with *A. montana*. The writer has had opportunities of comparing the two species in Burma and in Nyasaland. In both territories *A. montana* grows much more rapidly than *A. fordii* and attains a far greater size; the latter may be compared to an apple tree in size, whereas the former reaches a height of 60 to 70 feet when growing semi-wild in the Shan States. *A. montana* starts bearing earlier than *A. fordii* and gives much bigger yields in the first few years, and, in view of its much greater bearing surface and the fact that it bears its fruit in clusters whereas the majority of *fordii* trees are of the "single" type, it seems probable that it will always yield more than *fordii*. Even when allowance is made for the proportion of "male" trees always found in a plantation of *A. montana* (see below), and for the fact that *fordii* can be planted at least twice as densely, the indications are that *montana* will still give the greater yield per acre.

Methods of Establishing Plantations

Germination of Seeds.—Difficulty in obtaining germination of tung oil seeds has been reported from all parts of the world, and led to considerable delay in establishing the earlier trial plots where the seed had to be imported from China or America. This trouble will probably always be experienced where imported seed, which has had to stand a long sea journey, is used, and no practicable way of improving the germination capacity of such seed has been found, although loss of viability may be minimized by transporting the seed in the husk and by careful packing. When, however, seed can be obtained locally, satisfactory germination can usually be obtained provided that the seed is sown as soon as possible after harvesting. It should be sown in ordinary nursery beds without shade at a depth of $1\frac{1}{2}$ inches and a spacing of about 9 inches each way, the soil being kept as moist as possible without it becoming cold. The germination capacity decreases the longer the seed is kept after harvest, and keeping the soil thoroughly warm assists in obtaining good results. Mulching or shading of the nursery beds is therefore unnecessary unless the weather is particularly hot and dry.

Transplanting.—In the absence of previous experience of growing the trees as a plantation crop, planters have had to try out a variety of methods of establishing their groves, and in many cases this lack of knowledge of the procedure most suited to local conditions has resulted in relatively poor growth being obtained and has thus delayed progress. Probably the best way to establish a field of tung is to transplant seedlings nine to fifteen inches in height from the nursery bed early in the rains. Seedlings of both species are inclined to be tender and precautions should be taken to prevent wilting, by transplanting with a ball of earth about the roots, working on a rainy or overcast day, removing some of the leaves or shading, etc. The best results are obtained if the seeds are sown in baskets and all disturbance of the seedlings avoided by transplanting them in the baskets, but although this method is of value in planting small experimental plots, it is probably too expensive for application on a commercial scale. Plants may also be allowed to remain a year or more in the nurseries, where they can be cut back to a foot or eighteen inches of wood and transplanted as stumps. While satisfactory plantations of both species have been established in this way, the use of small seedlings usually results in better growth. In certain districts in Nyasaland, where a little rain can be relied upon during the dry season, some planters have found it advantageous to plant tung as stumps early in the dry season when their labour is not much required for other crops. These stumps make no growth above ground until the commencement of the following rains, when they come away quite well. Good results have also been obtained by sowing seed at stake in the field, but this method is not as reliable as the use of nursery plants and is not to be recommended unless climatic conditions are known to be favourable and a plentiful supply of relatively cheap seed is available.

Spacing.—Reports indicate a great deal of variation in the planting distances employed for both species. The spacing will naturally

vary with soil conditions, etc., and at present so little is known of the growth of the trees beyond the first few years that no very definite recommendation could be made. Clearly *A. montana* requires a much wider spacing than *A. fordii*. Full-sized trees of the former species will probably need to be 40 to 60 feet apart, but as they do not attain to their full size for some years it will be more profitable to employ a closer spacing when planting and to thin out later as required. It is suggested that the information now available indicates an original spacing of about 18 feet for *A. fordii* and about 30 feet for *A. montana*, both on the triangular planting system.

Subsequent Attention.—No special points can be made concerning subsequent attention to the trees. Pruning appears to be unnecessary except for the removal of dead wood or crowded branches. Some young trees always produce shoots from the base of the stem, and if a clean trunk is required these should be removed. If they are left the tree will develop a bushy shape, but there is no reason to suppose that this is a disadvantage except that in the case of *A. montana* some trees which branch very low tend to split when three or four years old. Manurial trials have been carried out in various places, notably in America [9], but while most of them have shown a response to the manure in increased growth and yields, the manuring has not been proved to be profitable, and in the absence of any definite knowledge of the cropping capacity of the trees, no general recommendation regarding manuring could be made at present.

Selection and Vegetative Propagation

It has been almost universally noticed that both species show great variation in vegetative characters, in their method of flowering, and in yield. The variation in flowering habit is of great importance, as it directly affects yield, but as yet there is not very much information available on the point and further study is very necessary. Both species are monoecious, but individual trees differ very much in the proportions of male and female flowers which they bear, especially in the case of *A. montana*.

The *fordii* inflorescence consists of one or more central female flowers surrounded by a large number of males. Clusters with a single central female flower are by far the commonest, but there are also trees which bear a number of female flowers in each cluster and some with many entirely male clusters. Some study of this and other variable characters in *A. fordii* was made some years ago in Florida [10], but no further work has been reported.

Trees of *A. montana* may bear inflorescences which are entirely female, entirely male, or which contain flowers of both sexes. The most important source of yield variation has been found in the fact that in any plot of this species a proportion of the trees are entirely male or at the most have only a few clusters containing female flowers. This feature was studied at the Tuyen Quang Experimental Station in Indo-China in 1929 and 1930, by counting the numbers of male and female flowers on 599 trees, when the following figures were obtained [1]:—

Table II.—Classification of *A. montana* Trees by Percentage of Female Flowers

Percentage of female flowers	Percentage of trees in each category	
	1929	1930
Per cent	*Per cent*	*Per cent*
0	29·5	22·8
0– 5	15·8	22·0
5– 15	4·8	5·5
15– 25	3·8	3·7
25– 40	2·8	2·5
40– 60	4·8	3·8
60– 75	2·5	3·3
75– 85	2·8	2·2
85– 95	3·5	4·2
95–100	9·7	14·3
100	20·0	15·7

It will be seen that approximately 44 per cent of these trees had less than 5 per cent of female flowers in each of the two years. The writer has also made rough estimates on two plots of young *A. montana* of the number of trees which bore no more than a few clusters containing females, and obtained in both cases a figure close to 40 per cent. These trees are usually very striking in a plantation, as they are commonly above average size and flower very profusely, but needless to say they yield little or no fruit. It has been suggested that such trees may undergo a change of sex as they grow older. The figures in Table II indicate that some change does occur from year to year, and the writer has noticed that trees which are entirely male one year may bear a few female clusters the following year. It is noticeable, however, that the trees at Zomba, which are now eight years old, so far show no *appreciable* change of sex, and as most of these "male" trees are large and more vigorous than those already cropping well, it seems very doubtful if it can be assumed that the production of only male blossoms in the early years is a temporary measure permitting

a strong vegetative development of the tree before fruiting. On the other hand, it has been claimed in Indo-China [11] that even if the proportion of females is an hereditary factor, it is equally influenced by climate and soil. Further investigations are needed, but the writer is convinced that there will always be a proportion of unprofitable trees in any plantation of *A. montana* established from unselected seed, and there is little doubt that the same applies to *A. fordii*. There is clearly urgent need for yield recording of individual trees with a view to the selection of high yielders, and the vegetative propagation of material from these good trees, and it is quite possible that only by utilizing such improved planting material will it be possible to establish profitable plantations. The budding of scions from good mother trees on to seedling stocks is likely to be the most useful method of effecting improvement at first, and the possibility of converting "male" trees of *A. montana* by top working is also worthy of investigation.

Selection has already been commenced in some countries, notably in Java, and in Indo-China, where seed from selected high yielders is already being distributed [11]. A certain amount of work has also been done on vegetative propagation, particularly bud grafting. Patch budding of *A. fordii* was successfully carried out at Gainesville, Florida, some years ago [10], and has since been used elsewhere. The same species has been both budded and grafted at the Subtropical Horticultural Research Station, Nelspruit [12], and budding by the shield and patch methods has also been successful in Brazil, Malaya, and Java [1]. In Russia, experiments were made over a period of three years with ring budding, patch budding and shield budding of *A. fordii* and *A. cordata*, the first method giving the best results, with 95 to 100 per cent of takes [13]. Other Russian trials at Batum gave similarly good results with shield budding [1]. The writer has used the method normally employed with rubber quite successfully for the budding of *A. montana* and *A. fordii* on to seedling stocks of *fordii*, *montana* and *moluccana*. Other methods of vegetative propagation likely to be of use in the multiplication of clonal root stocks have not yet received much attention. It has been stated that both *A. fordii* and *A. montana* have been raised from stem cuttings in Java [1], but negative results were obtained from this type of material in America [9], in Russia [1], and by the writer. In Russia [1] it is stated that *A. fordii* has been propagated from layers and all three species (*fordii*, *montana* and *cordata*) from root cuttings. The writer has raised a few plants of *montana* and *fordii* from layers and of *A. fordii* from root cuttings

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DERRIS OR TUBA ROOT

By R. R. Worsley, A.R.C.S., B.Sc., Ph.D., Biochemist, and F. M. Rogers, Superintendent of Plantations, Amani

Derris root is one of the most powerful insecticides known, but is harmless to man and animals. It does not possess the rapid "knock-out" power of pyrethrum, but weight for weight its eventual killing power is greater. It is finding increased commercial use in household sprays (mixed with pyrethrum), in fruit sprays, and in cattle dips; the powdered root is also much used for dusting purposes.

It is obtained from various strains of *Derris elliptica* and *D. malaccensis*. Rotenone is the chief toxic constituent of the root, and the content varies very greatly from 0.2 per cent up to about 12 per cent.

Malaya is the chief source of this root, although recent plantings have been made in the Dutch East Indies and other parts. The bulk of the root coming on the market is of very mixed botanical origin, and many complaints are made about its variable quality.

In 1928, Amani obtained cuttings of a high-grade *D. elliptica* from Kew Gardens, and it is these original plants that have been propagated for distribution throughout East Africa. The introduction of poor grades from Ceylon was made by one planter, but every effort has been made to destroy all the cuttings that he distributed, and legislation has since been passed to prohibit the importation of all derris material into East Africa. Planters should make certain that any derris they plant is of the approved Amani strain, which contains 9 to 10 per cent rotenone.

Reproduction and planting.—*Derris elliptica* has not yet been known to produce seeds in East Africa, and the method of reproduction practised has been by stem cuttings. Seedling plants cannot be relied upon to reproduce exactly the parental characters, but this is assured by the use of cuttings. Cuttings should therefore be taken from selected healthy plants of an approved high quality strain. The cuttings should be selected from matured wood, the thin whip-like ends of the runners being discarded. Node cuttings—that is, with the base of the cutting cut immediately below a node—are preferable to internode cuttings. The basal cut should be made cleanly with a sharp knife; ragged or sawn-off cuttings do not root readily. The length of the cutting is of little importance so long as one node, preferably two, is left above the basal node. All foliage being removed from these upper nodes, the cutting is ready for planting (see A, Fig. 1). The actual rooting of the cuttings presents little difficulty; in fact, quite a fair percentage can be rooted by standing the base of the cuttings in fresh water. For rooting under plantation conditions, however, it is advisable to prepare beds of river sand four inches deep with a light shade erected five feet above the beds. The cuttings are then inserted three inches into the sand, an inch or so apart, and the sand pressed firmly round the base (see Fig. 2). The beds should be kept moist throughout after planting. It is of course essential that the cuttings be inserted the right way up; we have heard of cases where complete failure was due to their being planted upside down. In approximately eight weeks the shade should be removed. This allows the plants to become more hardy before transplanting. In ten to twelve weeks from planting the cuttings should be rooted sufficiently for transplanting to their plantation quarters (see B, Fig. 1).

It is not advisable to take cuttings from plants that are being grown for the crop, since the root yield and even the rotenone content can be adversely affected by much cutting back. A plot should be set aside, preferably staked, for the supply of cuttings. In Amani a plant left for two years gives 20 to 25 cuttings, or for three years 50 to 80.

Spacing.—The most economic plantation distance has not yet been determined, but the question is under investigation in Amani. With spacing 4 ft. by 4 ft. a higher yield of root per plant is obtained than with 2 ft. by 2 ft., but the digging costs per plant are nearly double. Amani experience suggests that the latter is near to the optimum.

Staking.—The value of staking is not yet finally proved, but all preliminary work indicates a decided increase in yield of root if stakes are provided. In a recent trial, root yield was increased by about 60 per cent and leaf and stem yield by about 120 per cent. The stems and leaves have no commercial value except for cuttings, but, though no exact data are available, it is obvious that a high increase in leaf area will cause some increase in amount of root.

FIG. 1

A—(On the left) Derris cutting ready for planting in nursery bed.

B—Rooted derris cutting ready for transfer from nursery bed.

If the derris is planted 2 ft. by 2 ft., one stout stake about 10 to 12 ft. high (with about 3 ft. more below ground) to every four plants should be satisfactory. Close spacing considerably reduces the number of stakes required, and it is also probable that, other things being the same, staked plants need a somewhat smaller area than unstaked for the same amount of growth. The stakes are not put in until the plants are about one year old, and have begun to send out long runners. Old iron rails, etc., with wire between, also make efficient supports, but these are generally too expensive.

The staking of plants grown especially for multiplication also accelerates the maturing of the stem wood for cuttings.

Cultivation.—The only cultivation required is periodic weeding until the derris covers the ground.

Harvesting and preparation.—In Malaya, plants are harvested at 18 to 24 months old, it being stated that rotenone content drops and root yield does not increase beyond this age. This is not so in Tanganyika, where yield increases steadily up to three and a half years at least, and where rotenone content remains constant from two years onwards.

FIG. 2

Showing derris nursery beds. On right, plants about six weeks old are under shade (palm leaves across wooden supports). On left, about ten weeks old, with shade removed.

Taking into consideration seasonal conditions, i.e. the advisability of planting during the long rains, we have found a three-year cycle to be the most satisfactory. Cuttings are taken and the roots dug during March to April in Amani, i.e. about the beginning of the rains, and the rooted cuttings are then ready to plant out towards the end of May. The roots when dug are thus about 34 months old.

Ordinary digging forks and fork hoes are the most suitable implements for digging the roots.

When dug, a root will be seen to consist of the original cutting with a large calloused knob-like end. Roots not only come from this calloused end but also from the cutting above it. The cutting itself and the calloused knob must be discarded and only the roots proper retained. As much as possible of the fine root should be dug, but for a commercial harvesting the extra digging for the last pieces may be uneconomical. The roots should not be washed when dug but should be dried in the sun, or beneath a metal roof exposed to the sun, or by moderate artificial heat. Exposure to the sun should not last longer than necessary, i.e. only until the roots become brittle and snap when bent. They are then ready for marketing. Until more is known about the market requirements of East African derris, roots should be shipped whole, i.e. not chopped nor ground. Pressing the whole root into bales, and covering the bales with hessian cloth, has been found to be the most economic method of packing for export.

Yield of root.—The average yield per plant in Amani at 4 ft. by 4 ft. spacing over an area of one acre was 0.53 lb., or 1,443 lb. per acre; this was for plants two and a half to three years old. A preliminary result for a spacing of 2 ft. by 1½ ft. is 0.2 lb. per plant, or about 2,900 lb. per acre.

Commercial evaluation.—Two methods for the commercial evaluation of derris root are in use—the rotenone content and the ether extract value (the total percentage of matter extractable by ether). High-grade root is usually assessed by the former method; low-grade by the latter. Both methods are also frequently used in conjunction for the better grade roots.

Rotenone and ether extract values, as determined in the laboratory, are always expressed on a dry-weight basis, i.e. calculated to root with a nil moisture content. This serves as a standard comparison with any other root. The manufacturer, of course, buys on the amount of rotenone that he can extract from the root as he receives it, and hence his figure for

rotenone content will be lower than the laboratory one; thus 100 lb. of root with 8 per cent moisture and 9.2 per cent rotenone contains 8 lb. water, 9.2 lb. rotenone, and 92 lb. actual root; i.e. this 92 lb. actual root contains 9.2 lb. rotenone = 10 per cent rotenone on a dry weight basis.

Actual standards differ somewhat, but it can be said that manufacturers require a root with less than 10 per cent moisture and over 5 per cent rotenone and/or 17 per cent ether extract. With over 10 per cent moisture the root would probably be rejected and with less than 5 per cent rotenone a much reduced price be obtained. Rotenone contents well above 5 per cent can generally command a premium. One supply of root was sold by Amani in London in 1939 on the basis of 1½d. per lb. per 1 per cent of rotenone, and with 8 per cent content thus fetched 1/- per lb. At the beginning of this year we sold 8 per cent root on the American market at 16 cents (=9½d.) per lb.

Soil, climate, etc.—Derris has been grown successfully in Tanganyika from the coastal belt up to an altitude of 4,500 ft. The soil should be well drained and, for ease in digging, of light texture. This is important. In Amani one man can dig 14 plants, spaced 4 ft. by 4 ft., per day, whereas an instance has come to our knowledge where, on a very heavy soil, a man was able to dig only one plant a day.

The plant has grown well on soils generally regarded as of very poor quality. Preliminary manurial trials with dung, compost, superphosphate and lime gave no certain evidence of any benefit from these treatments. Nor, in pot cultures, was there any considerable fall in yield from serious shortages of nitrogen and potash or moderate shortages of lime and phosphate. Exact field manurial trials are, however, to be undertaken at Amani.

In general, derris appears to be a crop for a poor, sandy soil, and one which can stand a fair amount of drought when once established.

GRASSES AS INDICATOR PLANTS IN UGANDA—I

(*Continued from page* 22)

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NOTICE TO SUGAR CANE GROWERS

A number of sugar cane varieties, not previously available in East Africa, have now been released for general distribution. These varieties have passed through the Central Quarantine Station at Amani and have undergone preliminary trials at the Kawanda Experiment Station of the Uganda Department of Agriculture. Applications for cuttings should be addressed to the Director of Agriculture of the territory in which the applicant is resident.

The available varieties are shown in the following list, together with remarks by Mr. C. G. Hansford on their performance in the Uganda trials:—

Co. 421—No mosaic disease. Very vigorous and even growth. Germination excellent and stools very well.

Mayaguez 49—No mosaic disease. Appears a good cane.

" 61—No mosaic disease. Appears a good cane.

" 151—No mosaic, but growth poor and appears unsuited to Uganda conditions.

P.O.J. 2803—No mosaic. Appearance fair.

Many further imported varieties are also under trial in Uganda. Notice of their release will be made from time to time in this journal.

FURTHER NOTES ON THE "WOODINESS" DISEASE OF PASSION FRUIT IN KENYA

By R. M. Nattrass, B.Sc. Agric. (Lond.), Ph.D. (Lond.), D.I.C., Kenya Department of Agriculture

(*Received for publication 24th May, 1940*)

In this Journal (Vol. V, 2, 130-133, Sept., 1939) a preliminary note appeared on the "woodiness" disease of passion fruit. A brief account was given of the disease as it occurs in the Trans Nzoia district, and a reference was made to another form of the disease which occurs in the Sotik district, some 150 miles to the south. Although suspected of being caused by a virus, as is the Trans Nzoia disease, proof was lacking. It was generally believed by growers that this form of the disease was due to soil or climatic conditions or possibly the lack of some essential element. Consequently, no attempt was made to control the disease by the eradication of affected vines.

The symptoms of the Sotik disease differ considerably from those of the Trans Nzoia. In the plantation little or no evidence of the disease appears on the foliage, but the effect on the fruit is most marked, and is indeed the only certain indication of the presence of the disease in the plantation. It is true that what appear to be more severe types than others do produce an effect on the foliage, but it is often transient and the absence of this symptom is no evidence of the absence of the disease. Generally, even though carrying "woody" fruit, the foliage differs hardly, if at all, from that of healthy vines. As far as observations at present indicate, there appears to be no spread of the disease from certain foci, but affected vines occur sporadically throughout a plantation.

The occurrence of "woody" fruit is variable. Fruits on a single dropper only may be affected while others appear normal, and even "woody" and normal fruit may occur on the same dropper. Sometimes one side of the vine only is affected, but in most instances the whole vine carries "woody" fruit.

The fruit may be affected in a variety of ways; the more severe manifestations being a distortion of the whole fruit with one or more large swellings corresponding to areas of woody tissue, or the whole fruit may be reduced to a small more or less spherical mass of hard woody tissue with an almost entire disappearance of the internal cavity.

One of the first indications that a vine is affected is the presence of one or more round yellowish spots, which may be up to a quarter of an inch in diameter, on the surface of the green fruit. These offer considerable resistance to cutting and indicate the position of "woody" tissue in the shell of the fruit. The presence of this can usually also be confirmed by pressure of the thumb at these points.

In the early investigation of this disease attempts to transmit the disease by inoculating healthy seedlings with juice and crushed tissue from diseased plants failed, although the same method succeeded readily with the Trans Nzoia type. A number of cuttings from typically affected vines were brought from Sotik and grown on their own roots at Nairobi. These eventually matured and produced "woody" fruit. Two vines with no abnormal foliage symptoms, but having produced no fruit, were inarched on to young vigorous vines. Some months later, both stock and scion produced "woody" fruit. A number of young vines were grafted with cuttings direct from diseased vines. These also eventually produced "woody" fruit. From these vines the disease was again passed to healthy vines by the same method.

It appears therefore that the Sotik disease is also caused by a virus, but is not so readily transmissible as the Trans Nzoia virus. It is probably not spread by the hands of workers or by means of pruning knives, which probably accounts for the comparatively slow spread in the plantation. Nevertheless, it does spread, and few plantations are entirely unaffected. It is almost certain that here also, as has been shown to occur with the Trans Nzoia virus, it is disseminated by aphids, but proof of this is, as yet, lacking.

With this type of disease successful control by roguing is more likely to be attained than with the Trans Nzoia type, as natural spread is slow and there does not appear to be the attendant danger of inadvertently infecting neighbouring plants by handling. It is recommended that as soon as a plantation comes into bearing frequent inspections be made and all vines producing "woody" fruit destroyed. The gaps can safely be replanted without delay. Seedlings for this purpose should be raised in an isolated spot as far removed from the main plantation as possible. The disease is not transmitted to the seed, and even seed from "woody" fruit will produce healthy plants.

REVIEWS

THE UTILIZATION OF ANIMAL BY-PRODUCTS IN THE COLONIAL EMPIRE.

This roneoed publication from the Colonial Office has been compiled from data supplied by the Veterinary Departments of the various colonial dependencies. It consists of a preface by Professor W. C. Miller, of the Royal Veterinary College, and a survey of the facilities for utilization of animal by-products in the various colonies.

In his preface, Professor Miller discusses the importance of the by-products of animal slaughtering in providing supplementary foods for live stock and manure for the soil. His preface is a concise statement of the various methods employed in processing animal by-products and of the analyses of the products so obtained.

From the summary of information given in the body of the bulletin, it is seen that animal by-products are processed to produce animal foods only at two slaughterhouses in Kenya, at the Zanzibar Abattoir, and at one abattoir belonging to the Demerara Meat Co. in British Guiana. In Kenya, processing is carried out at the Municipal Abattoir, Nairobi, and at Messrs. Liebig's Factory, Athi River, and it is stated that no difficulty is experienced in the disposal of the by-products, although much depends upon the prosperity of the agricultural community. In British Guiana, the Demerara Meat Co. manufactures a small quantity of meat, bone and blood meal, which is sold as compounded poultry feed, and in Zanzibar, blood only is processed by mixing with bran and sun-drying, the resultant product being utilized in compounding poultry rations.

In none of the other colonial dependencies is there any production of animal foodstuffs from this source, and it is perhaps a little astonishing that in Palestine, with its large concentrations of urban population, and its intensive system of farming, particularly poultry farming, that there is no systematic production of animal foodstuffs from the by-products of slaughter. Generally, throughout the Colonial Empire, there seem to be two factors which account for failure to utilize the profitable by-products of the slaughterhouse. One is the small scale upon which operations are conducted at most slaughterhouses in the colonies. There are, however, exceptions to the latter statement, e.g. Colombo, Kandy, and Hong Kong, and the Colonial Office publication should render valuable assistance in drawing the attention of the authorities to the possibilities of utilizing a valuable source of supplementary foodstuffs for animals.

The second factor against the utilization of by-products is the relatively low standard of living of the native populations, which ensures that much of the materials available in Europe or America for the by-products plant is directly utilized as human food. Horns and hoofs will, however, always be rejected, and in this connexion Professor Miller draws attention to the number of commercial uses still found for horn. Where horn industries are impracticable, the valuable fertilizing qualities of horn and hoof should receive consideration. The drying and grinding of horns and hoofs are comparatively easily carried out, and no great amount of skill is needed to operate the plant. The bones of the feet, and the bony horn cores may readily be removed by soaking in scalding water just below boiling point for about half an hour or less. The horny material is then dried and ground into a coarse meal. It is rich in ammonia, and is a valuable fertilizer.

RESEARCH ON GRASSLAND, FORAGE CROPS AND THE CONSERVATION OF VEGETATION IN THE UNITED STATES OF AMERICA: Compiled by R. O. Whyte, Herbage Publication Series, Bull. 26, Imp. Bureau of Pastures and Forage Crops, Aberystwyth, Great Britain; Sept., 1939; pp. 1-113; 5/-.

The Imperial Agricultural Bureaux continue to serve us with zeal and timeliness. In this latest publication of the Pastures and Forage Crops Bureau at Aberystwyth, Mr. Whyte (who, it will be recalled, was a joint author with Mr. G. V. Jacks of *The Rape of the Earth*) summarizes for convenient reference the very extensive researches of the Americans in the field of forage-crop cultivation, pasture improvement and range management.

The first chapter deals with investigations on alfalfa (lucerne), the clovers, soy beans (a versatile crop, useful for hay, pasture, silage, soil improvement and food production), and a number of miscellaneous legumes. A section on grasses follows, in which attention is drawn to fundamental investigations of many kinds bearing on such important questions as seed setting, resistance to diseases like the smuts and ergot, the response of strains to different light intensities and lengths of day, and protein content.

An interesting reference is to experiments on intergeneric hybrids between the grain cereals and numerous grasses. "Grain hay" is an important crop in some parts of the United States, where soil moisture is exhausted too early in the season for a sowing of a cereal crop to mature a harvest of grain, and in this American work towards developing strains or hybrids of the common cereals as forages, we have an example that could perhaps be profitably followed in East Africa. It is possibly in this direction that a solution of the difficult problem of the best utilization of heavy *mbuga* lands is to be sought, particularly in semi-arid districts where native stock-keepers are to be helped to reduce grazing pressure on the erodible soils of lighter consistence.

The United States Forest Service by no means confines its interests to forestry as the term is commonly understood. It devotes staff and resources also to range management problems in unenclosed areas where trees may be few, or trees and pasturage share the ground, but where the best use of land for grazing needs to be reconciled with the maintenance of values in other directions. Many of their methods, and the outlook illustrated by them, are of general appeal, and Mr. Whyte devotes a stimulating chapter to them. "Twenty years' results on south-western semi-desert experimental ranges, with regard to range management in relation to severe periodic droughts . . . show marked contrasts with heavily stocked unregulated range of potentially equal productivity. For instance, the grazing capacity on the managed range is double that of the unregulated, net calf production is more than half again larger, and death losses are only one-fifth to one-third. . . . The density of vegetation reflects the growth conditions of the previous year. Thus the stand of forage plants may be only one-fourth as much in the year following drought as in the year of drought." There is interesting matter in this and later chapters on the techniques of re-vegetation of overgrazed lands—but the horse that pulls a seed-drill (equipped with outriggers) up a "slope of 72 degrees" (p. 25) is surely no other than Pegasus himself!

The research projects of the Division of Research, Soil Conservation Service, are summarized in the next section, which takes the compiler somewhat outside the ordinary field of his Bureau, for it mentions many investigations that deal with geographic and climatic factors, soil characteristics, and irrigation and drainage questions. However, the reminder is useful that "practically all aspects" of these basic researches "are of direct or indirect interest to grassland and forage crop specialists." Attention is again drawn to fundamentals in a chapter summarizing recent ecological and physiological work of Clements and his co-workers, carried out under the auspices of the Carnegie Institution at the Desert Laboratory in Arizona, the Alpine Laboratory on Pike's Peak, and other experimental gardens.

The last half of the compilation deals with the various States in turn, summarizing the contents of recent annual reports of experiment stations in regard to pasture and forage work. The information given is rather miscellaneous, but illustrates the wide scope of possible field (and also biochemical) investigation in this branch. There are good indexes of subjects and plant names, and several maps.

All concerned with such work in East Africa will wish to have this publication handy, to keep them in mind of likely lines to follow. We could wish some subjects had been more fully treated, but this after all is not a text-book, only a guide; we have *Herbage Abstracts* to give the detail. Thus an article on "range survey standards" is notified as to appear in an early number of that periodical.

The moral for us of Mr. Whyte's compilation seems to be this: Keep in touch with what's doing elsewhere in the world and apply the results of others where you can; but be alive to the complexities. Pastoral science and soil conservation are not yet exact philosophies like physics, and each region presents its problems in terms of different sets of natural conditions. Principles do emerge, but they are not absolute. Sometimes they are little more than hints; they must be tested and developed for local application, much more so when reported from another continent. Do not let us rely too much on American researches for light upon our East African problems; let us investigate for ourselves, and start with the fundamentals.

G.M.

REARING OF CHICKENS ON A WIRE-NETTING FLOOR

By Geo. Ernst, Manager, School Farm Dairy, Peradeniya

Reprinted from The Tropical Agriculturist, *XC*, 1938, *pp.* 354-357

Towards the end of the year 1936 there was a high mortality among chickens at the School Farm, Peradeniya. Losses from coccidiosis, roundworm infestation, and gapes were mainly responsible for the high death-rate, which in some cases reached 50 per cent of the hatch.

Suitable fresh ground, the most essential requirement in chicken-rearing, was not available on the farm, where poultry had been kept under semi-intensive conditions for seven or eight years. Periodical turning up of the soil, liberal applications of lime, and resting of runs had been carried out, but these efforts were attended with little success. It was therefore decided to try rearing the chickens off the contaminated ground—on wire-netting—as this system had been well reported on from other parts of the world and was in use in Ceylon at Wester Seaton, Negombo.

A makeshift pen was constructed by fitting legs to an ordinary rectangular chicken coop and replacing the wooden floor by one-inch wire-netting. A small coop (to which an additional framework of wire-netting was fitted about three inches above the floor level) was placed against the entrance to the coop, and served as a shelter for the chickens at night.

A batch of 43 chickens was reared in this manner until they were two months old, when it was necessary to remove them from the brooder as they had acquired the vice of feather-eating, which in two cases resulted in cannibalism. This appears to be the only drawback in this system of rearing chickens, but it has been remedied to an appreciable extent by hanging up small bundles of grass or bones with shreds of meat on them, so that the chickens are kept busy pecking at them most of the time. That close confinement was solely responsible for this vice was clearly shown by the fact that the chickens ceased all such activities once they were given more scope on the ground. At this stage the chickens were found to have made splendid growth, and being about two months old were able to withstand parasitic infection to a greater degree than they would have done had they been exposed to similar conditions as baby chicks.

The success which attended the rearing of the first batch of chickens prompted the writer to design and have constructed a more elaborate type of brooder, as shown in the illustration.

This brooder consists of three compartments, one closed in with half-inch planks on the outer sides for housing the chickens at night, ventilation being provided for through the partitions between this and the next compartment, which is wire-netted on all sides and roofed to provide shelter from the rain and excessive heat of the sun. The third is an open-air compartment intended for use during favourable weather.

In order to prevent contamination of food and water, the troughs are placed on the outside of the brooder, the chickens having access to them through openings in a galvanized zinc sheet, which is fitted with a sliding shutter and enables adjustment of the openings to suit the size of the chickens. Zinc-lined dropping boards are provided to facilitate cleaning and to obviate the necessity for shifting the brooder from place to place. The cost of constructing a brooder of the dimensions shown in the plan, using *sapu* timber and 24-gauge zinc sheets, is approximately Rs. 45 (Sh. 67/50).

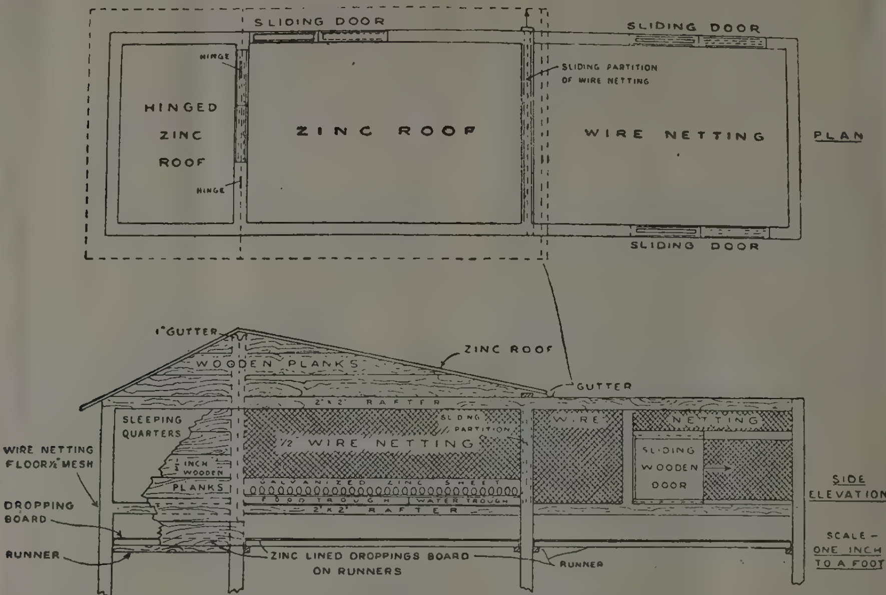
Too much emphasis cannot be laid on the necessity for providing the chickens with all their requirements. The provision of some form of grit, vegetables and meat scraps should not be overlooked, as the chickens are entirely dependent on the rearer for these necessities.

The method of rearing chickens in these brooders which has proved a success at the farm at Peradeniya is detailed below.

The newly hatched chickens, after drying, are transferred from the incubator to the hover, which consists of an ordinary wooden box with a wire-netting framework on top. Heat is supplied by a hurricane lamp, round which is placed a circle of wire mesh to prevent the chickens from coming in contact with the heated lantern.

No food is given to the chickens until about thirty-six hours after the time of hatching. Any weak or crippled chickens are then picked out and destroyed. A mixture of broken rice and *kurakkan* (*Eleusine coracana*) in equal parts is given to the chickens in a shallow trough; they soon begin to peck at and eat the grain, which should be given them at intervals of three hours.

Care should be taken to provide sufficient warmth for the chickens. Any undue chirping should be looked into and the cause remedied. A supply of clean fresh water for drinking should always be available, and this is best provided in the form of a shallow drinking fountain, which prevents the water being soiled and the chickens from getting themselves wet



in attempting to drink. When the chicks are about five or six days old, a little dry bran is added to the *kurakkan* and broken rice. Skim milk or diluted whole milk is substituted for water, and care should be taken to see that the troughs are well scalded with boiling water every day. When the chickens are about a week old they are transferred to the chicken brooder with wire-netting floor. In cold weather a lantern will be necessary both day and night until the chickens are about a fortnight old, but when warm weather prevails the lantern will be required only at night. The chickens are then given alternate mash and grain feeds every three hours. The mash mixture consists of the following:—

	lb.
Maize (finely ground)	10
Pollard	25
Wheat bran	15
Sussex ground oats	10
Rice bran	12
Linseed poonac	3
Fish meal	6
Bone flour	2
	83

Two per cent cod-liver oil is added to the mash just before it is required for feeding. Sufficient water or skim milk is added to the mash mixture to make it friable. The grain mixture is made up of the following: Kurakkan 2 parts, broken rice 1 part, crushed wheat 1 part.

The frequency of feeding may be reduced to four times a day and may be given as follows: 7 a.m., grain feed; 10.30 a.m., mash feed; 2 p.m., grain feed; 5 p.m., mash feed.

The quantity of food to be given at each meal would depend entirely on the appetite of the chickens, and will be approximately that which they would consume in about half an hour. A tray containing clean sand or fine gravel, and fragments of charcoal, should be made available to the chickens. Small bundles of grass, spring onions, cabbage leaves, etc., should be hung up here and there inside the brooder, so that the chickens get sufficient exercise in jumping for them. Meat scraps should be given twice a week.

The chickens are reared in the brooder until they are two months old, but in case they develop the vice of feather-eating and cannibalism it may be necessary to have them shifted on to the ground earlier. This should only be resorted to when other methods fail to prevent the chickens pecking at each other. When isolated cases occur it would be best to segregate the injured chickens and paint their wounds with tincture of iodine. Cutting off the end of the upper mandible has been advocated, but this has not been attended with much success. The chief thing to aim at is to keep the chickens busy all the time, and the suspending of vegetables, grass, meat scraps, etc., helps to a great extent.

PASTURE RESEARCH

A New Method of Measuring Ground Cover and Composition of Permanent Pastures

By R. N. T.-W.-Fiennes, B.A. (Cantab.), M.R.C.V.S., Veterinary Department, Uganda

(*Received for publication* 26*th February*, 1940)

The method of measuring ground cover and percentage composition of the permanent pastures at the Veterinary Laboratory, Entebbe, Uganda, is thought to possess advantages of quickness and simplicity of use.

A 30 ft. rope marked off at every foot is used to make a transect. For each transect 10 estimations are made at intervals of 3 feet. The rope is laid along the ground and readings are taken at every third mark along the rope.

To make the estimation, a wire frame is used, the internal dimensions of which are 1 inch by 10 inches. The frame is further marked into squares of 1 inch side. This frame is laid alongside the rope at the chalk mark, and all species that naturally come within its area are recorded. A record is kept only of the species present and not of the numbers of each. If a creeping species is present, such as *Cynodon dactylon,* its presence is recorded if it crosses within the frame, irrespective of whether a rootstock is present or not.

The ground cover within the frame is easily estimated from the squares; for instance if it is estimated that 1½ squares are uncovered by vegetation the ground cover is clearly 85 per cent. Before calculating the ground cover, the finger is rubbed along the soil within the frame in order to remove debris and to facilitate the reading. But if, as in the case of some species, a true "litter" has been formed, this is regarded as constituting a ground cover. This is important as the litter formed by *Cynodon dactylon* for instance may be as much as ½ inch thick.

Five transects should be made per acre, and the transects should be sited in a routine manner, in order that the records may be purely random and not due to either conscious or unconscious selection of the site—a very real danger in grass work. For instance in a long field, which is fairly uniform, it might be decided to make the transects at regular intervals down its length; in a square field, they could be taken both up and across; or it might be decided to take them diagonally either one way or both ways across the field. One method should be selected for a particular shape of field and this should be adhered to for every such field. When it is wished to repeat the observation—and this should be done yearly—it is well to vary the method of site selection.

Where a zoning of vegetation is encountered, the transects should be made along a line at right angles to the zones. In order to get a true reading for the field as a whole, it is if course most important that the distances between transects should be accurately calculated and measured.

A typical transect would be as follows:—

Species	Ground cover
Hyparrhenia filipendula	0
Hyparrhenia rufa	7
Loudetia kagarensis	
Hyparrhenia filipendula	5
Cyperaceae	
Loudetia kagarensis	8
Imperata cylindrica	
Digitaria scalarum	9
Hyparrhenia filipendula	
Eragrostis mildbraedii	8
Brachiaria brizantha	
Eragrostis mildbraedii	10
Hyparrhenia dissoluta	
Hyparrhenia diplandra	7
Hyparrhenia dissoluta	
Hyparrhenia diplandra	
Hyparrhenia filipendula	8
Paspalum notatum	
Hyparrhenia diplandra	
Hyparrhenia dissoluta	6
Cyperaceae	
GROUND COVER	68%

COMPOSITION—

Hyparrhenia filipendula	4	i.e. 19	per cent
Hyparrhenia rufa	1	,, 5	,,
Loudetia kagarensis	2	,, 9	,,
Cyperaceae	2	,, 9	,,
Imperata cylindrica	1	,, 5	,,
Digitaria scalarum	1	,, 5	,,
Eragrostis mildbraedii	2	,, 10	,,
Brachiaria brizantha	1	,, 5	,,
Hyparrhenia dissoluta	3	,, 14	,,
Hyparrhenia diplandra	3	,, 14	,,
Paspalum notatum	1	,, 5	,,

N.B.—The percentages are, of course, normally only calculated for the field as a whole and not for each individual transect.

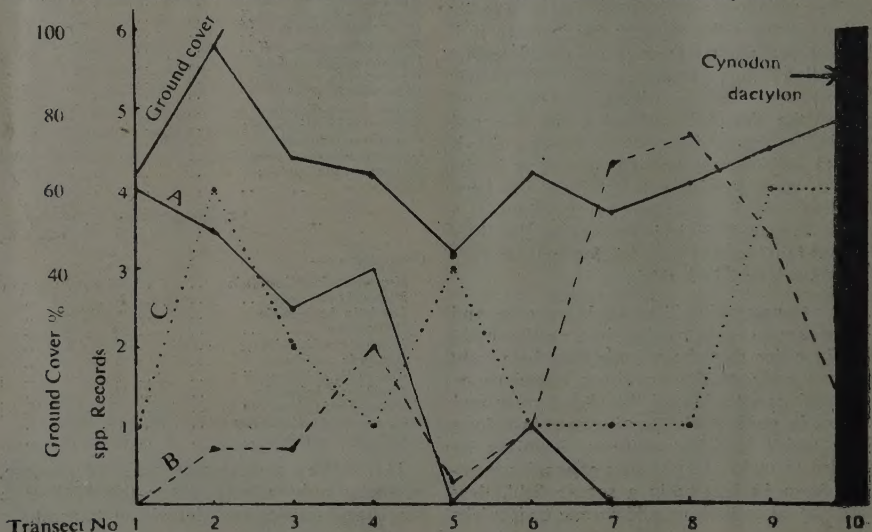
A complete record for a two-acre field would be as follows :—

	1	2	3	4	5	6	7	8	9	10	Total	Percentage	Grd. cover
												%	%
Hyparrhenia rufa ..	4	0	1	0	0	0	0	0	2	0	7	4.0	1. 65
Loudetia kagarensis ..	6	3	2	1	0	2	0	0	0	0	14	8.0	2. 97
Andropogon shirensis ..	2	0	0	1	0	0	0	0	0	0	3	1.7	3. 68
Hyparrhenia dissoluta ..	2	4	3	5	0	0	0	0	0	0	14	8.0	4. 64
Cymbopogon excavatus ..	1	0	0	0	1	0	0	0	0	0	2	1.0	5. 42
Cyperaceae ..	1	4	2	1	3	1	1	1	4	4	22	12.5	6. 64
Brachiaria brizantha ..	1	1	1	0	2	0	0	0	1	0	6	3.4	7. 55
Eragrostis patens ..	0	3	0	1	0	0	0	4	0	0	8	4.5	8. 61
Digitaria scalarum ..	0	2	1	5	1	1	5	6	1	2	24	13.6	9. 71
Hyparrhenia filipendula	0	2	4	2	0	3	1	0	0	0	12	6.8	10. 73
Imperata cylindrica ..	0	0	1	0	3	2	1	0	0	4	11	6.3	
Eragrostis mildbraedii	0	0	2	2	3	3	0	0	0	0	10	5.7	
Hyparrhenia diplandra ..	0	0	3	0	0	0	1	0	0	0	4	2.4	
Paspalum notatum ..	0	0	1	1	0	2	4	3	2	0	13	7.4	
Brachiaria kotschyana ..	0	0	0	0	1	1	0	0	0	0	2	1.0	
Pennisetum purpureum	0	0	0	0	0	0	0	0	0	1	1	0.6	
Panicum maximum ..	0	0	0	0	0	0	4	5	7	1	17	9.7	
Cynodon dactylon ..	0	0	0	0	0	0	0	0	0	6	6	3.4	

TOTAL GROUND COVER .. 66 per cent

It will be clear at a glance from the above table, that the transects traverse at least two different vegetational zones. To get a complete picture of the flora of this field, it will be of great assistance to plot these figures graphically. Two different "associes" seem to be concerned, and we may, therefore, plot our graph using the average figures for the various constituents of each. The first associes appears to be mainly *Loudetia kagarensis-Hyparrhenia dissoluta,* the figures for which at each transect are added together and divided by two; the other main "associes" appears to be *Digitaria scalarum-Paspalum notatum-Panicum maximum*; the figures for these are added together and divided by three. We thus get a comparable figure for the two associes. The Cyperaceae appear to be uniformly distributed throughout the transects, and as they are an important constituent may be separately plotted. At transect 10, *Cynodon dactylon* appears to be "dominant", and it may be represented in this situation by a column. The resultant graph, which is reproduced here, gives a useful composite picture indicating the flora of this pasture. A further curve can now be plotted above to show the variation of ground cover.

Two interesting points stand out from this curve. Firstly, at the tension zone between the two associes is a kind of "no-man's land", in which the Cyperaceae are especially abundant. Secondly, although the ground cover provided by each associes is satisfactory, at the tension zone, it is definitely less so.



A—*Loudetia kagarensis–Hyparrhenia dissoluta* "associes".
B—*Digitaria scalarum–Paspalum notatum–Panicum maximum* "associes".
C—Cyperaceae.

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